ARE PEOPLE RESPONSIVE TO WATER RATIONING POLICIES?

STUDY OF SASKATOON OUTDOOR WATER RESTRICTIONS, SUMMER 2011

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By

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ABSTRACT

It is difficult for policymakers to predict the behavior of people in response to a water rationing policy. The public may not necessarily behave as expected or in accordance with market rules or policy mandates. In this research, I will ask whether people were responsive to a summer 2011 City of Saskatoon legal restrictions to reduce their outdoor water consumption due to reduced capacity at the water treatment plant resulting from excessive solids in the river water. I will try to explore the policy response - which can be expressed as a reduction of outdoor water consumption in 2011 in response to the water mandate - while holding constant other factors, including environmental variables (temperature and rainfall), socio-economic factors (income and education level), lot size, and an annual downward trend in water consumption that appeared in many North American cities during the past two decades.

Monthly water consumption data for the period from 2004 to 2012 for the City of Saskatoon were analyzed to detect if there is a policy response from the water mandate during June and July 2011. Regression analysis with water consumption as the dependent variable and lot size, temperature, rainfall, education index, income, consumption trend, and policy as independent variables was conducted to test whether there is a policy response in the Saskatoon water records, holding other factors relevant to water consumption constant.

Results showed there was a statistically significant reduction in Saskatoon water consumption during June and July 2011 as a result of the water rationing mandate, with considerable variations through different neighborhoods. In addition, there is a positive relationship between water consumption and lot size and a reduction in water consumption over the research period from 2004 to 2012. The policy response varied widely across neighborhoods,

and there was relationship between policy and annual income per capita, and household size; households with more income per capita are less responsive to the policy while bigger household sizes showed more policy responsiveness.

Key words: City of Saskatoon, water rationing, water policy, water mandate, outdoor water use.

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ABBREVIATIONS

AWWA	American Water Work Association
ET	evapotranspiration
ft^3	cubic foot (1 ft^3 = 28.3 liter)
g	gallon (1 gallon = 3.78 liter)
gpcd	gallon per capita per day
KL	kiloliter or 1000 liters
NHS	National Home Statistics
SDA	Suburban District Area; Saskatoon has a core neighborhood area and 9 SDA's
SEAC	Saskatoon Environmental Advisory Committee
SPSS	Statistical Package for the Social Sciences a software package used for statistical analysis
SRC	Saskatchewan Research Centre
WC	water consumption, usually expressed in ft^3 per month

CHAPTER 1

INTRODUCTION

Cities must contend with the ongoing challenge of managing urban water demand. Residential water demand in Canada accounts for more than 40 % of total demand (Statistics Canada 2011). With the increase of the population of the cities, limited resources of freshwater, climate change, other increased demand for urban water for industrial purposes and restricted budgets to construct new treatment plant or even to expand existing ones, cities are under continuous pressure to curb total water demand to avoid or at least delay high costs associated with the construction or expansion of water treatment plants.

Like other North American cities, the City of Saskatoon uses a large portion of its total water consumption for outdoor purposes. Outdoor water consumption peaks during the summer season at more than 50% above normal. Outdoor water demand comes from garden irrigation, pools and spas. The limited production and pumping capacity of the city's water treatment plant, which was constructed in 1906 and the limited storage facilities have to be designed to meet the water consumption demand at its peak during summer. It has become increasingly difficult for the City to meet the peak demand coming from outdoor usage of water for irrigation (Annual Report 2012), especially with the steady increase of the city population.

The number of households (defined as residential unit which has a water meter) served by the City increased from 62,244 properties in 2008 to 67,221 in 2012, with an average 1.6% increase per year in number of housing units. Pressure on supply was reduced by 3.1% for the same period from reductions in the average annual demand, due to lower per household use (Annual Report

2012). The total consumption of the last five years fell from 36 million cubic meters in 2008 to 34.9 million cubic meters in 2012. The City of Saskatoon Annual Report for 2012 states also that the reason is that recent wet summers reduced the need for residential and commercial irrigation, although per household residential water consumption was down in most North American cities because of the introduction of high efficiency appliances and fixtures (Commes et al., 2010).

Efforts to reduce peak water consumption (the amount of water consumption that treatment plant capacities have to be designed for) were directed toward outdoor consumption, which is often thought to be discretionary and related to many behavioral, weather, and socio-economic factors. In a recent study focused on California water districts, De Oreo et al. (2011) found that outdoor use increased significantly with increases in evapotranspiration (ET), household income, landscape ratio (the theoretical requirement for irrigation based on the presence of vegetation and ET, and the presence of pools.

Many policies can be employed in stages, or together, to attain reduction in outdoor water consumption. An educational-oriented policy focuses public messaging and relies on voluntary reduction of water consumption. This type of policy has limited impact if there are no penalties for noncompliance. Kenny et al. (2004) showed that mandatory restrictions were more effective than voluntary ones in reducing water use under drought conditions on Colorado communities. Kenny et al. also expressed caution, however, about whether these restrictions would work over the long-term, explaining their efficacy results from cooperation and goodwill in response to short-term emergency drought conditions. It is unclear whether people would respond in the same way if asked to conserve on a long-term basis. Olmstead and Stavins (2009) have questioned whether these behavioral changes will be temporary or permanent. Other issues include whether people even know these mandates are in effect and whether there is enforcement by the City. Larson and

Brumand (2014) found that regulations sometimes are not known by urban residents and therefore cannot be followed. In the study of compliance in Phoenix, Larson and Brumand also found that city officials often do not apply fines or other penalties. Enforcement of such laws tends to be complaint-driven, and residents will rarely call to complain about such matters.

This research will address the impact of water policies (mandatory restrictions) on residential water consumption in the City of Saskatoon during the summer 2011. Water restrictions were put in place because of lower capacity at the water treatment plant due to high levels of solids in the water. Water consumption patterns will be evaluated to determine whether the mandated restrictions affected residential consumption for the city as a whole and for its different neighborhoods. Effects of income, education level, houses lot sizes, and annual trend will also be related to water consumption through regression analysis. The essential task was to determine whether policy had a significant effect on residential consumption, holding other relevant variables constant. The analysis was conducted using SPSS V20 software to run regressions for the data in the months of June and July for the years between 2004 and 2012; the mandates were in effect during June and July 2011. The analysis accounts for the effects of summer weather conditions, recognizing that outdoor water demand is sensitive to temperature and precipitation. The source of water consumption data (2004 to 2012) is the City of Saskatoon.

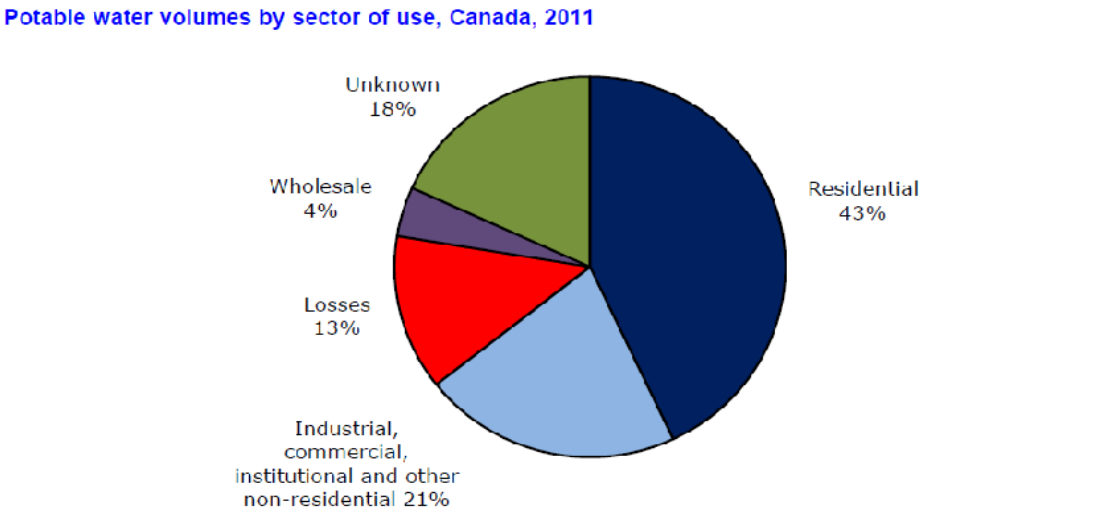
CHAPTER 2

BACKGROUND

Urban water demand is an important part of the total water demand all over the world. The world average urban water use is 8 % of the total water use (22 % for industrial and 70 % for agriculture) (United Nations 2003). In high income countries, this percentage of urban water use is 11%. Moreover, a costly treatment process is required for urban water. Canada spent CAN$1,336 million as capital expenditure on the addition, expansion, and upgrading of existing water treatment plants in 2011. The total cost of operation and maintenance during the same year was CAN$882 million. In 2011, Statistics Canada estimated the total production of drinking water for that year was 5,103 million cubic meters. The cost of operation and maintenance of drinking water in 2011 was more than 17 cents per cubic meter (not including the capital cost of new plants or the expansion costs of existing ones) plus pumping, storage, distribution, and administrative costs. A considerable portion of treatment and distribution costs is related to energy.

Water turbidity refers to relative cloudiness of water and is reported in nephelometric turbidity units (NTU). According to a survey of water treatment plants (Statistics Canada 2011), one of the highest median values of monthly maximum turbidity in raw surface water sources occurs in Saskatchewan (**Figure 6**). During summer of 2011, the City of Saskatoon issued a mandatory outdoor irrigation water restriction with $300 as minimum fines to address a filtering problem at the water treatment plant. The filtering problem had greatly restricted daily production capacity. It resulted from the high levels of sand, clay, and silt drawn into the plant from the fast flowing Saskatchewan River. (City of Saskatoon releases 2011).

Urban water demand in North America is affected by a wide range of demographic, economic, behavioral, and cultural and policy factors (Gober and Quay 2011). Residential water demand is substantial part of total urban demand. In Canada, residential or domestic demand account for 43% (more than 50% in Saskatchewan) of total municipal or urban demand (Statistics Canada 2011). Other uses include institutional, industrial, commercial, parks, and golf courses (**Figure 1**).



Source: Statistics Canada 2011

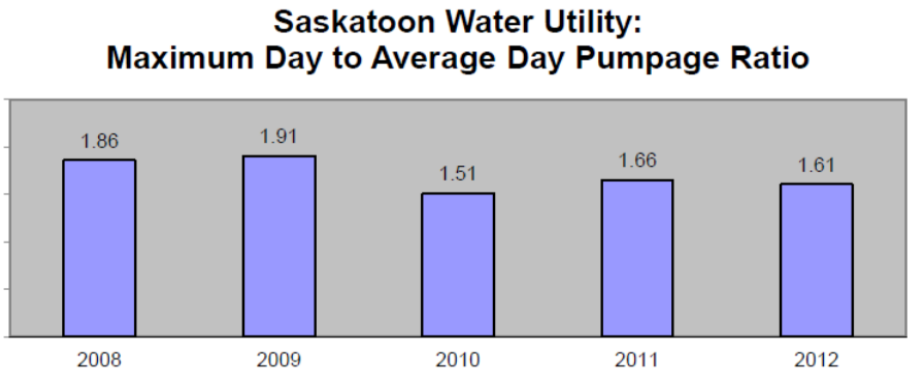
Figure 1: Potable water volumes by sector of use, Canada 2011

The demand for residential use is divided into two categories: indoor water use comprising bathing, showering, laundry, kitchen, drinking, and cleaning; and outdoor water use comprising irrigation of gardens, private swimming pools, and car washing. According to the Environment Protection Agency - USA (EPA), watering lawns and gardens constitute more than half of outdoor

water use. In the USA, landscape irrigation is estimated to account for nearly one-third of total use. (EPA 2013).

The amount of water used in a community varies over the course of a day and throughout the year as a result of differences in instantaneous water use among users over time. For example, in residential areas, water use peaks in the morning and early evening when most residents are preparing for work and/or meals.

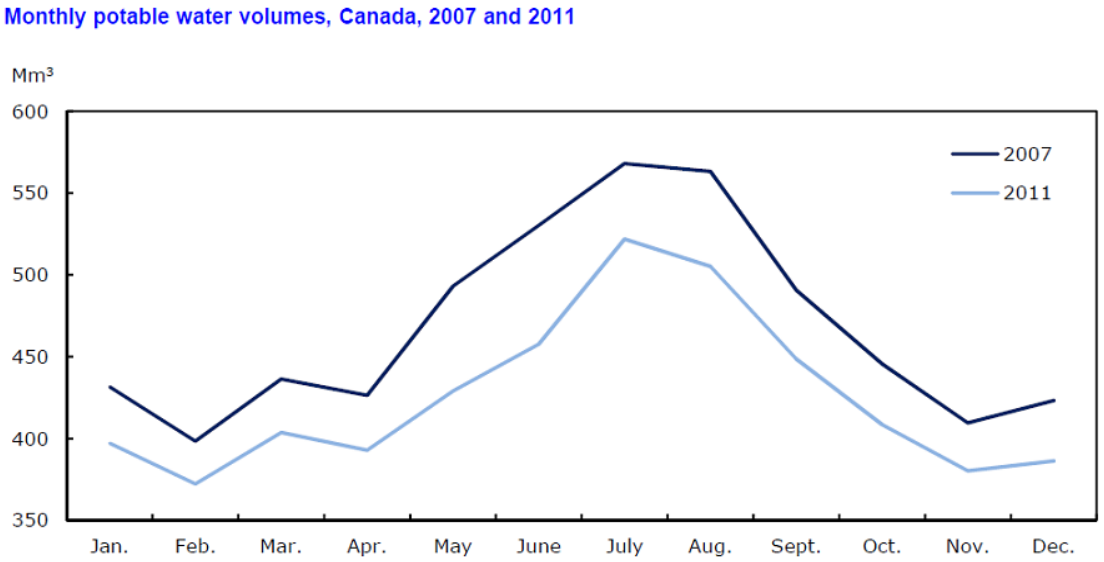
Most communities experience elevated water demand in the summer when gardens and lawn watering requirements are highest (CBCL Ltd. 2011). Statistics Canada showed similar seasonal fluctuations in municipal water use in 2007 and 2011, ranging from a low of 372 million cubic meters in February to a peak of 522 million cubic meters in July 2011. Climatic conditions during the summer season have a substantial impact on outdoor water usage. For example, rainy and cool summers reduce the need for frequent lawn watering (Statistics Canada 2011). City of Saskatoon pumped water peaks are from 51% to 91% higher than daily year averages, which is a similar comparative figure for other Canadian and American Cities (City of Saskatoon Annual Report 2012). (**Figure 2**)



Source: 2012 Annual Report – Water and wastewater treatment branch

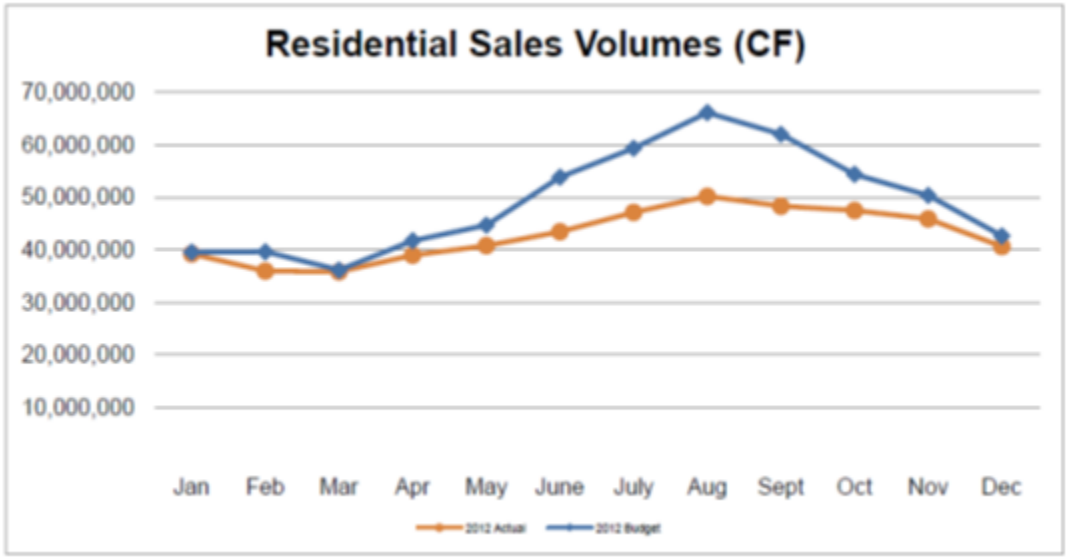
Figure 2: Maximum day to average day pumpage ratio in Saskatoon

High summer water demand places significant pressure on the City's water treatment plant, which was built in 1906. (**Figure 3** for Canada and **Figure 4** for Saskatoon monthly demand). City data also showed summer peaks in water consumption between years 2004 to 2012 (**Figure 5**).



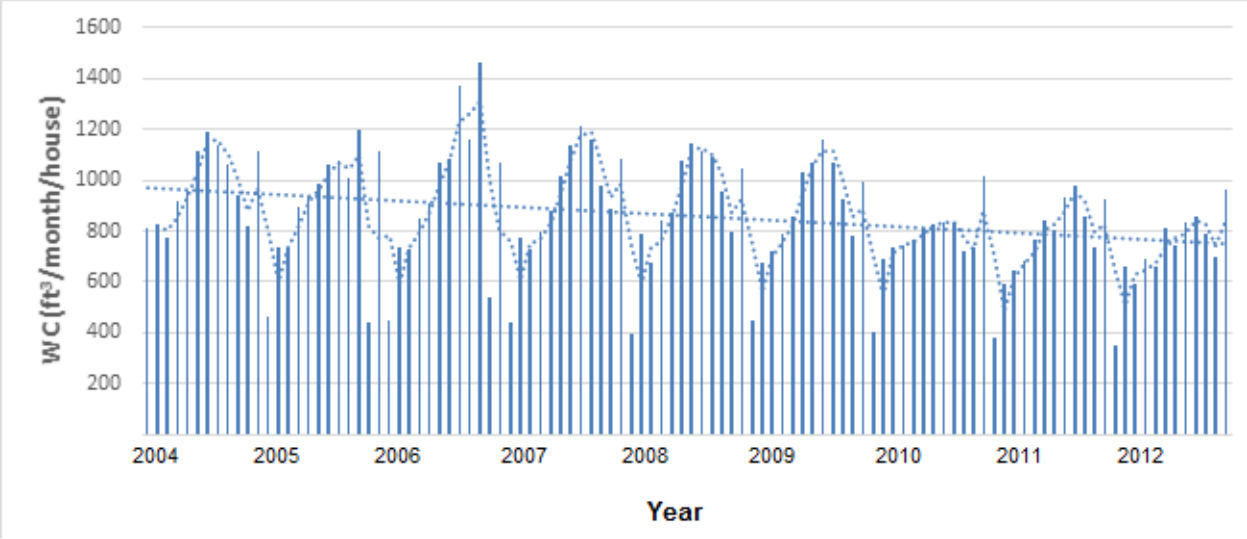
Source: statistics Canada 2011

Figure 3: Monthly potable water volume, Canada 2007 and 2011



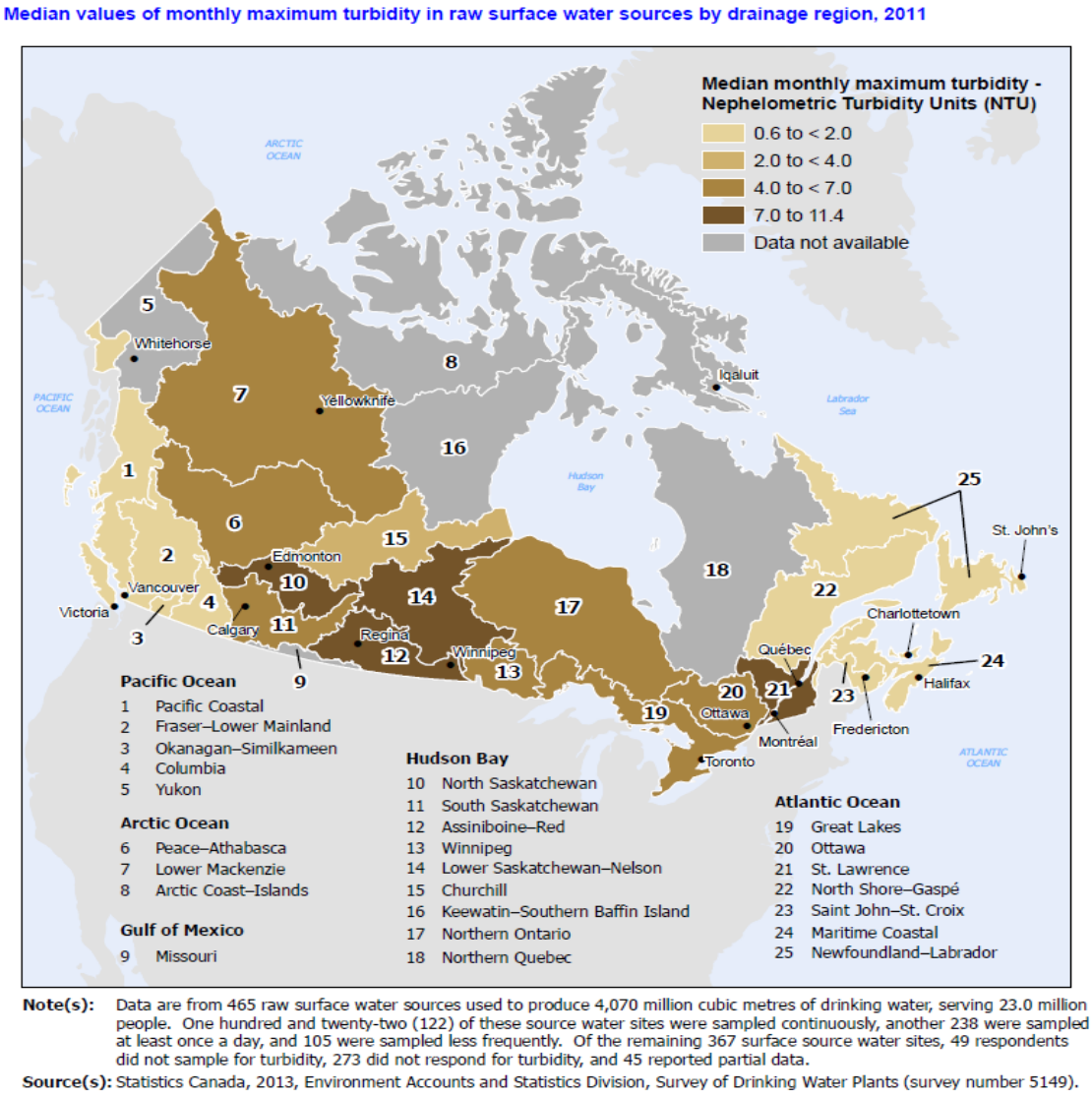
Source: 2012 Annual Report – Water and wastewater treatment branch

Figure 4: Residential sales volumes in cubic feet in Saskatoon 2012



Source: Data set provided by City of Saskatoon

Figure 5: Saskatoon neighborhood household monthly average consumption 2004-2012 with trend



Source: Statistics Canada 2011

Figure 6: Median value of monthly maximum turbidity in raw surface water sources by drainage region, 2011

The City of Saskatoon depends on a single water treatment plant. Along with three potable water storage reservoirs, that plant is responsible for supplying consumers with safe and reliable potable water at an acceptable pressure (City of Saskatoon Annual Report 2012). Consumers

include residential households, commercial and industrial businesses, institutions, and golf courses within the city. The City of Saskatoon also sells potable water to SaskWater at seven supply points around the perimeter of the city. SaskWater then re-distributes the supply to 27,298 consumers outside of Saskatoon (City of Saskatoon Annual Report 2012).

Average water consumption per household (a living unit which has a single meter that is part of the data set) in Saskatoon over the research period is 11,390.7 ft^3 per year (323.6 KL or 85.6 K gallon) in 2006 and 8,660 ft^3 per year (245.3 KL or 64.9 K gallon) in 2012. Considering that the average household size is 2.5 persons, indoor and outdoor water consumption was 95.7 gallons per capita per day (gpcd) in 2004 and 71.1 gpcd in 2012, (**Table 1**) which was below the average of selected North American cities (De Oreo et al 1999). The average North American total daily per capita usage was found to be 172 gpcd with 69.3 gpcd coming from indoor uses, 101 gpcd coming from outdoor uses, and 1.7 gpcd from unknown or unidentified use (De Oreo et al 1999). The mix of indoor and outdoor was strongly influenced by annual weather patterns (De Oreo et al 1999). For indoor water consumption, Saskatoon was slightly above average in 2006 with indoor water consumption of 70.6 gpcd, and below average in 2012 with indoor water consumption of 59.2 gpcd. Even so, the City's data are in the range of what has been observed in North American cities (**Table 2** and **Table 3**).

Table 1: Yearly annual, indoor, outdoor, and water use in Saskatoon

Year	Annual water use (Kgal/house)	Indoor water use (Kgal/house)	Outdoor water use (Kgal/house)	Outdoor annual water use
2004	87.4	69.9	17.5	20.0%
2005	79.8	66.2	13.6	17.0%
2006	85.6	65.4	20.2	23.6%
2007	83.1	65.6	17.5	21.1%
2008	80.9	61.0	19.9	24.6%
2009	78.9	64.5	14.4	18.3%
2010	68.3	62.1	6.2	9.1%
2011	68.5	53.0	15.5	22.6%
2012	64.9	53.4	11.5	17.7%
All years	77.5	62.4	15.1	19.5%

Source: Data set from City of Saskatoon.
Outdoor was calculated according to equation 1.

Table 2: Comparison household size and mean daily per capita indoor use

Study site	Mean person per household	Mean daily per capita indoor use (gpcd)
Seattle	2.8	57.1
San Diego	2.7	58.3
Boulder	2.4	64.7
Lompoc	2.8	65.8
Tampa	2.4	65.8
Walnut Valley WD	3.3	67.8
Denver	2.7	69.3
Las Virgenes	3.1	69.6
Waterloo and Cambridge	3.1	70.6
Phoenix	2.9	77.6
Tempe and Scottsdale	2.3	81.4
Eugene	3.5	83.5
12 study sites	2.5	69.3
Saskatoon (2006)	2.54	70.6
Saskatoon (2012)	2.47	59.2

Information about North American cities reproduced from De Oreo et al 1999 table 5.1.

Information about Saskatoon obtained from data set.

Table 3: Comparison outdoor, indoor, and total annual water use

Study site	Sample size	Outdoor annual use (kgal/home)	Indoor annual use (kgal/home)	Total annual use (kgal/home)	Outdoor annual water use
Waterloo	37	7.8	67.7	75.5	10.3%
Cambridge	58	7.8	71.2	79.0	9.9%
Tampa	99	30.5	56.1	86.6	35.2%
Lompoc	100	43.5	62.1	105.6	41.2%
Seattle	99	21.7	54.1	75.8	28.6%
Saskatoon (2004)	50,000	20.2*	65.4	85.6	23.6%
Saskatoon (2012)	50,000	11.5*	53.4	64.9	17.7%
Saskatoon (Average)	50,000	15.1*	62.3	77.5	19.5%

* Assuming lowest month except January (see equation 1
Information about North American cities reproduced from De Oreo et al 1999 table 5.14.
Information about Saskatoon obtained from data set.

It is difficult to measure exactly the indoor and outdoor components of the water consumption; the seasonal or outdoor water use component can be estimated using Equation (1); this method assumes the minimum month usage contains no outdoor component. (De Oreo et al 1999). In my study, I used that equation and excluded January as the usage reported during this month is extremely low due to the system of calculating water bills in Saskatoon (Yobb, Twyla personal communication, August 11, 2014), the purpose of choosing the lowest month is to select a month without outdoor component, but due to high inaccuracy of the January readings as mentioned earlier lowest month reading other than January was selected (see figure 5).

$$Q_{out} = (Q_{annual} - Q_{min.} \times 12) \quad (1)$$

Where: Q_{out} = mean annual outdoor household use;

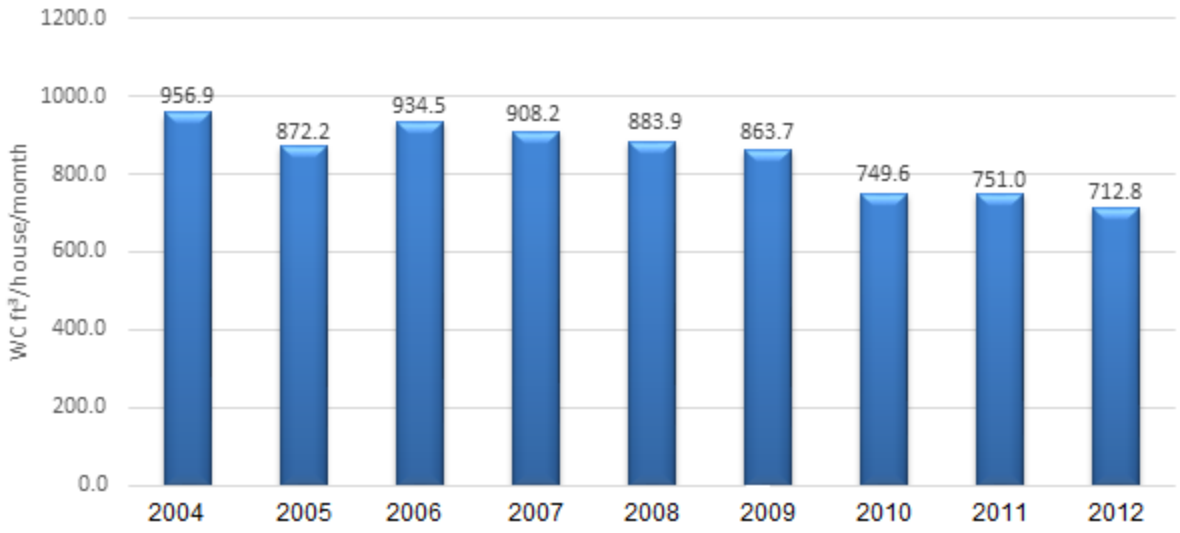
Q_{annual} = mean annual per household water use;

Q_{min} = mean minimum monthly per household water use (except January).

Saskatoon outdoor water consumption constitutes 19.5% of the total annual water consumption, with a minimum of 9.1% in 2010 which has the highest rainfall in June and July and maximum of 24.6% in 2008 which had one of the hottest months and lowest rainfall in June (**Table 1**).

Continuous efforts to reduce water consumption in Saskatoon started in 2009. The Saskatoon Environmental Advisory Committee (SEAC) applauded the City of Saskatoon's interest and willingness to improve its water conservation efforts, including adoption of a new water rate structure in December 2009 and a goal to reduce peak water demand by 10% over the next two years. The policy of restricting outdoor water use in the City of Saskatoon in 2011 was intended to reduce the peak usage of water during June and July 2011 due to the limited capacity of the treatment plant at that time. The City of Saskatoon wanted to send the message to reduce outdoor water use through mandated restrictions. Despite these efforts, Saskatoon lags behind other Western Canadian cities in its water conservation efforts. To this end, SEAC commissioned a Green Legal summer student, from the University of Saskatchewan's Faculty of Law, to produce a report entitled "Municipal Water Conservation Programs and Bylaws: Current Practices and Recommendations" (Minutes of Meeting Saskatoon, Nov. 2010). The City of Saskatoon currently offers no rebate programs or other incentives for low-flow toilet or low-flow fixture installation and the water prices remain significantly below other cities in Alberta, Manitoba, and Saskatchewan. (City of Saskatoon 2015). The education program was started under the title of **"Be**

water wise." The program included a 2.5-minute video and brochures focusing basically on summer outdoor water saving (City of Saskatoon 2009). A comparison of residential sales during winter months showed a steady decline in per capita daily indoor consumption of 3.9 % per year since 2008, or a total decline of 14.7 % (City of Saskatoon Annual Report 2012). Studies from other municipalities confirm that this downward trend in indoor residential use has been occurring over the last decade (Coomes et al., 2010). Although quite significant now, it is anticipated that this trend will flatten out after existing households are fitted with low-flow fixtures and high-efficiency appliances. The decline in indoor use accounts for 64 % of the total decline in the average daily per capita consumption when irrigation is considered (City of Saskatoon Annual Report 2012).



Source: City of Saskatoon data

Figure 7: Trend in household's average monthly water consumption in Saskatoon 2001-2012

CHAPTER 3

RESEARCH HYPOTHESES

The limited capacity of the Saskatoon treatment plant can be exacerbated by accumulation of sand in the filters due to the fast flowing river. This situation occurred during June and July 2011, which created a water supply problem for the city. It became increasingly difficult for the City to meet the peak demand from outdoor usage of irrigation water (Statistics Canada and Annual Report 2012). The City of Saskatoon imposed restrictions on outdoor water consumption. On June 13, 2011, the first release requested a voluntary reduction (City of Saskatoon 2011, release US11-263). This release followed by another one on June 15 that shutoff water parks and asked residents not to use spray parks (City of Saskatoon 2011, release US11-269). At the same day, the City issued another release mandating restriction for outdoor use and encouraging residents to reduce indoor water use (City of Saskatoon release 2011, US11-272). On June 22, the City announced that unauthorized outdoor irrigation would be ticketed starting at $300 (City of Saskatoon release 2011, US11-295). Enforcement was to continue until July 11, 2011, when the water restriction mandates were lifted (City of Saskatoon release 2011, US11-333 and the City of Saskatoon website). These mandates were the first "water rationing" or "outdoor water restrictions" applied in the City in addition to the continuous reservation policy started in 2009.

The water restriction period lasted for a period of 30 days (June 13 to July 11, 2011). Within that timeframe, the mandatory water restriction was in place for 20 days (June 22 to July 11, 2011). This period can be classified as a short-term emergency drought. On the one hand, people are more apt to respond to short-term as opposed to long-term restrictions policies but, on the other hand, there may not have been enough time to get the message across. In addition, this particular

water conservation event was unrelated to local weather conditions and therefore more difficult for local residents to understand the need for outdoor conservation, but on other hand it might helped for more compliance as the lawn will not suffer much in normal weather condition.

In this research paper, I will explore whether the mandated restrictions reduced household use, while applying controls for other factors that may affect water consumption. In addition, I will also examine whether the impacts of water conservation messages varied by neighborhoods with different income and education levels. The first hypothesis is:

> **Hypothesis 1:** City of Saskatoon residents restricted their water consumption during the policy period in June and July 2011 in response to the City's call for restricted use, although the response level varied by neighborhood.

A second line of inquiry relates water use to the size of the irrigated area. The amount of outdoor water consumption increases proportionally with the size of the landscaped areas or irrigable area and, accordingly, the amount and percentage of outdoor water use is more in case of large lots. Conversely, there is less outdoor water consumption in small lots. Allen (1999) found that per capita water consumption was higher in a low-density development neighborhood than in a high-density neighborhood. Chang et al (2010) found that in Portland, Oregon the average number of houses per acre (building density) had a negative relation with water consumption: if the average number of houses per acre increases by one unit, there will be water reduction of 4904 liters (171.5 ft^3) per household consumption. Obviously, the increased amount of water consumption in large lot size areas will be because of higher outdoor consumption for gardening.

> **Hypothesis 2:** Households with bigger lots will have higher water consumption because they have more land available for outside irrigation. I will assume that the policy, which

mainly addressed outdoor reduction, would have significantly larger impact on houses with larger lots because the percentage of outdoor consumption to total water consumption is higher than those of smaller lots. The policy coefficient is higher in neighborhoods of larger lot sizes.

The first part of the hypothesis was tested by conducting a regression analysis with water consumption as the dependent variable and lot size as an independent variable. Then the policy coefficient through neighborhoods was checked and compared with neighborhood average lot sizes.

Many conservation programs focus on persuasion, which requires cooperation by citizens toward the goal of preserving or providing a common good (Campbell 2004). The City started an educational campaign in 2009 to inform people about the importance of cooperation in water conservation. In the face of its turbidity problem in 2011, the City released a series of announcements and mandates for water conservation. The first release US11-269 on June 15, 2011 called for voluntary reduction of water use by citizens before a second release mandating water restrictions a week later. Results from the AWWA survey show that conservation is considered important by at least 70% of all those responding to the questions. (De Oreo et al 1999)

I hypothesize that persons with higher education are more informed and hence are more responsive to water reduction policy. This hypothesis will be tested by checking the policy coefficient of a neighborhood compared to its education level.

Hypothesis 3: The effectiveness of the policy, is more with highly educated neighborhoods that are apt to receive communication and can realize the importance of government

programs. Policy coefficient is assumed to be higher in the neighborhoods of high education index.

High income persons usually have bigger houses and tend to spend more on their houses, especially on the backyards lawns (Coomes, et al. 2013). Subsequently, total and outdoor water consumption reduction is related to annual household income. The research scope did include the mandate issued on June to July 2011 that authorized Saskatoon Fire and Protective Services staff to issue tickets starting at CAN$300 if non-compliance with the outdoor restriction was reported and proven (City of Saskatoon release US11-295). There is abundant evidence in the literature that high income people are not responsive to price and fines. I assume that high income people are less responsive to water restriction mandates and the applied fines because the costs and fines matter less to them. Moreover they have more equity in their homes thus more to lose if the lawn goes dry or trees die. This hypothesis will be tested by measuring the effectiveness of the policy among different income levels within the neighborhoods.

Hypothesis 4: Monetary fines or incentives are more impactful in low- than in high-income neighborhoods.

High income people consider their lawns to be part of their personalities and they are less responsive to monetary pressure. Neighborhoods with high annual income will not respond to the policy and will have lower or no policy coefficient compared to other neighborhoods

CHAPTER 4

DESCRIPTION OF DATA SET

The original data set obtained from the City of Saskatoon contained water consumption data in cubic feet per month per unit and lot sizes in square meters. Data include residential (houses, townhouses, or apartments), industrial, commercial, golf clubs, and institutional units. These data span the period from 2004 to 2012 on a monthly basis.

The final data set after removing the outliers and inactive categories includes monthly water consumption readings of 91 neighborhoods for a period of nine consecutive years from 2004 to 2012. Each record has a rate category, lot size, neighborhood identifier in addition to monthly water consumption. The total monthly readings range from 668,141 readings in 2004 for an approximately 55,678 units to 743,047 readings for 61,920 units in 2012.

Because the research question is related to the outdoor residential water policy response, the data set was filtered to include residential water use only. Data for commercial, golf clubs, irrigation, runoff, industrial, and multi-residential (which is related to apartment buildings and complexes) use were excluded. The original data set was examined for missing observations or unusually large observations (more than 10,000 ft^3 per month). These cases where then deleted from the final data set.

The total number of neighborhoods after filtration is 50; Every neighborhood has full record all over the research period, the smallest community has 266 units in Richmond Heights; Silver Wood Heights is the largest community with 2879 units. The average number of units per

community is 930 units with 46,526 households; all the readings are in cubic feet per household per month.

WATER CONSUMPTION AND WATER USE

Water consumption is the portion of water use not returned to the original water source after being withdrawn. Consumption occurs when water is lost into the atmosphere through evaporation or incorporated into a product or plant and is no longer available for reuse (Reig 2013). **Water use** describes the total amount of water withdrawn from its source to be used. Water use has two components; non-consumptive water use returns to the local river system and is mostly indoor use; consumptive water use is mostly outdoor use.

This research is about water use; but the data set received from the City has used the term Water Consumption "WC" instead of water use or water demand and defined the consumption as the amount of water estimated by the City officer or measured by the City water meters for each household every month that has two components indoor and outdoor. In order to maintain the consistency with the City data set I will be using the same term as the dependent variable in the data analysis. The measurements are usually taken every two to three months and averaged for monthly consumption (Yobb, Twyla personal communication, August 11, 2014). Water consumption is measured in cubic feet.

LOT SIZES

Lot sizes are available for each house in square meters in the data set received from the City of Saskatoon (every house has a lot). Lot size expresses the surface area of the land of the household. Average lot size of the data set is 608.8 m^2. **Appendix A** shows the average lot size for each neighbourhood. Irrigable area can be described as the portion of a lot that has the potential to

support a landscape which, depending on the desires of the occupants, could be irrigated at least part of the year (De Oreo et al 1999). For a particular house, it is possible to calculate the irrigable area by deducting the footprint of the house, garage, deck, and paved driveway from the total lot area. Lacking information about the built-up areas, this study assumes that the lot size is proportional to the irrigable area and uses lot size as an indicator of irrigable area.

City of Saskatoon has complete statistical information (from Statistics Canada) for every neighborhood in the 12th Edition of the Neighborhood Profiles, November 2013. Data used in this research combines the City's statistical data with water records and climate data from the Saskatchewan Research Council.

POPULATION

Total number of persons living in a neighborhood is available from Statistics Canada 2006 and 2011. Population was not used in the analysis; but examined to provide context for each neighborhood.

HOUSEHOLD SIZE

Average household size is the average number of permanent persons per household based on the 2006 and 2011 national census. Saskatoon has an average of approximately 2.5 persons per household for the selected neighborhoods, which is comparable to average household size in other North American cities (**Table 2).** The City's average household size did not change over the period from 2006 to 2011. The maximum household size is 3.3 and 3.2 in 2006 and 2011, respectively (noted to occur in Lake Ridge); the minimum household size is 1.7 and 1.6 in 2006 and 2011 in City Park. Smaller households usually reside in the core neighborhoods dominated by single adults and older couples. New neighborhoods with young families and children are often found in

outlying areas. For more information about each neighborhood household size, refer to **Appendix A**. Household structure will be used to convert variables per household to per capita for comparison purposes.

INCOME

Income is defined as the average household income per year in Canadian Dollars (CAD$). Data on income per neighborhood was obtained from Statistics Canada Federal Census and Generations on 2006 and 2011 National Home Statistics (NHS). For analysis purposes, 2011 data were used as it falls at the time of policy. For the research period, Saskatoon average income per household was CAN$62,436 in 2006, which increased by 32.6% to CAN$82,826 in 2011; Lowest income neighborhood in 2006 and 2011was in Pleasant Hill CAN$25,776 and $40,295 per household. The highest income in 2006 was in Briarwood CAN$105,651 per household, and in 2011 it was in Arbor Creek CAN$161,882 per household; core neighborhoods have usually less income per household than new neighborhood (**Appendix A**).

EDUCATION

2011 NHS provides the education level of the neighborhood residents under five categories; the education level categories are as follows:

No certificate, diploma, or degree;

High school certificate or equivalent;

Apprenticeship or trades certificate or diploma;

College, CEPGEP (post-secondary education collegiate), or non-university certificate or diploma;

University diploma or degree.

Education index for a neighbourhood was calculated as the sum of persons with a college diploma or university degree divided by total number of people in the neighborhood.

$$E = (C + U) \div (N + S + A + C + U) \quad (2)$$

Where: E = education index;

N = number of people without a certificate, diploma, or degree;

S = number of people with a high school certificate or equivalent;

A = number of people possessing an apprenticeship or trades certificate or diploma;

C = number of people possessing college, CEPGEP, or non-university certificate or diploma;

U = University diploma or degree.

Value of the education index ranged from 0 to 1 and has no unit. The maximum education index was 0.68 at Grosvenor Park, the minimum was 0.19 at King George, and the average value of the education index was 0.43. For more detail about education indices for different neighborhoods, see **Appendix A**.

AGE OF DWELLING

Age of dwelling refers to the period in which the building was originally built, not the time of any later remodelling, additions or conversions. Age of dwelling (G) is estimated in years from construction year till to date (2015) according to equation (3). The source of information is from National Household Survey (NHS), Statistics Canada – Federal Census 2011.

Information about construction time are given as number of dwelling built in the following periods:

D_1 number of houses built before year 1960

assume $Y_1 = 2015 – 1945 = 70$ years (built in 1945)

D_2 number of houses built between years 1961-1980

assume $Y_2 = 2015 – 1970 = 45$ years (built in 1970)

D_3 number of houses built between years1981-1990

assume $Y_3 = 2015 – 1985 = 30$ years (built in 1985)

D_4 number of houses built between years 1991-2000

assume $Y_4 = 2015 – 1995 = 20$ years (built in 1995)

D_5 number of houses built between years 2001-2005

assume $Y_5 = 2015 – 2003 = 12$ years (built in 2003)

D_6 number of houses built between years 2006-2011

assume $Y_6 = 2015 – 2008 = 7$ years (built in 2008)

$$G = [D_1 (Y_1) + D_2 (Y_2) + D_3 (Y_3) + D_4 (Y_4) + D_5 (Y_5) + D_6 (Y_6)] \div [D_1 + D_2 + D_3 + D_4 + D_5 + D_6] \quad (3)$$

Where: G Average age of dwellings for a neighborhood in years

D_i Number of dwellings originally built in defined time period

Y_i Years from the time of construction till do date

Age of dwelling represents a socio-economic factor, older neighborhoods such as city core neighborhoods have small household size containing single people and older couples compared to

new neighborhoods on the urban fringe occupied by families with children. Older neighborhoods houses were not originally equipped with water saving fixtures and also have slow transition to newer ones.

RAINFALL

Rainfall is the quantity of water, expressed in millimeters (mm) that precipitated as rain, snow, hail, or sleet in a specified area and time interval. In this research, rainfall is the total monthly rainfall amount in millimeters recorded at the Saskatchewan Research Council site during summer months of June and July (data obtained from the Saskatchewan Research Council). Rainfall in June and July historically precipitates in a form of rain and ranges from maximum 147.2 mm in June 2010 to a minimum 39.8 mm in July 2006.

MAXIMUM TEMPERATURE

The maximum temperature is the average of the maximum temperatures in a month expressed in degree Celsius. Records for maximum temperature are available for the city as a whole for the research period. For this research, the maximum temperature was measured by Saskatchewan Research Council site in degree Celsius.

APPLICATION RATE

Application rate of water for a property is the depth of water applied over the entire irrigable area during a single year (De Oreo et al 1999).

$$A = (3.78 \times 10^9 \times V) / (I \times 10^6) \quad (4)$$

Where: A = millimeters of water applied to the irrigable area;

V = annual outdoor use in kilo gallons;

I = irrigable area in square meters.

Assuming lot size minus the building footprint and paved area (7.5% of the lot size), the average irrigable area in Saskatoon was:

Building footprint = 1,500 ft^3;

Paved Area = 7.5% of lot size;

Average lot size = 608.8 m^2 (6,551 ft^3);

I = 6,551 ft^2 – 1,500 ft^2 – (0.075 × 6,550 ft^2) = 4,560 ft^2 or 424 m^2.

The average application rate of Saskatoon assuming that 80 % of outdoor quantities was used for irrigation was:

A= 0.80 × (15.1 K gal × 3.78 ×10^9) ÷ (424 m^2 × 10^6) = 107.7 mm (4.2 inch) per year.

The Saskatoon average application rate is below the average of North American cities. See **Table 4** for more information. One reason could be that Saskatoon is located in a colder region than most of North American cities and therefore less water is needed to maintain grasses and trees.

Table 4: Irrigable area, application rate, annual precipitation, and average annual temperature

Study city	Average irrigable area (ft^2)	Average annual outdoor use (K gal)	Average application Rate (inch)	Annual precipitation (mm)	Average annual temperature (^oC)
Cambridge	6998	7.8	3.1	1130.3	6.9
Waterloo	5951	7.8	2.9	1130.3	6.9
Seattle	6058	21.7	7.7	1404.6	12.9
Tampa	12361	30.5	6.3	1376.7	22.8
Lompoc	4696	39.9	14.9	457.2	15.6
Eugene	6863	46.7	16.9	1186.2	12.1
Boulder	6512	72.9	16.7	426.7	10.9
San Diego	5904	99.3	33.1	434.3	17.8
Tempe	7341	100.3	47.5		
Denver	7726	104.7	28.3	266.7	11.1
Walnut Valley	10282	114.8	27.4	569.0	19.3
Scottsdale	4968	156.5	34.9	101.6	22.3
Phoenix	9075	161.9	38.6	101.6	22.3
Las Virgenese	16306	213.2	36.0	340.4	18.3
Saskatoon (2006)	4560**	20.2*	5.6	517.5	4.1
Saskatoon (2011)	4560**	11.5*	3.2	319.8	9.6
Saskatoon (average)	4560**	15.1*	4.2	335.0***	2.2***

* Assuming lowest month except January (see equation 1).

** Obtained from data set.

*** From weather network.

Information about North American cities reproduced from De Oreo et al 1999 table 5.15 and 4.4.

ANNUAL TRENDS

The available data covered the period from 2004 to 2012. In analysis of the data, annual trends were considered one of the independent variables. Two possible factors impacting the trend of water consumption reduction were:

- General trend in North America mainly due to new water saving fixtures in existing houses and newly built houses equipped with new fixtures;
- Awareness and conservation campaign by the city for total and outdoor water reduction.
- The new revised pricing structure after 2009, as it appears in Figure 5 there is a noticeable drop in water consumption after 2009. This pricing effect was not included separately in the regression analysis.

I will consider all factors acting together and will provide a trend slope of water consumption. See **Figure 5** for annual trend of the monthly average water consumption.

CHAPTER 5

DATA ANALYSIS RESULTS

Several models were analyzed to determine whether there was a policy response in 2011 and the effects of the different control variables such as lot size, neighborhood, weather, and socio-economic status.

MODEL I

A cross-sectional regression analysis was conducted on full panel data.

Dependent Variable:

WC is the monthly water consumption for every household during months of June and July from 2004 to 2012 in cubic feet. To remove the outliers, all WC values smaller than 100 ft^3 per household per month and bigger than 10,000 ft^3 per household per month were removed.

Independent Variables:

- Policy (P): A dummy variable consisting of a value of 1 for 2011 (at the introduction of the policy) and 0 for all other years.
- Lot Size (H): Lot size in square meters for every house. Lot sizes more than one acre (4047 m^2) were excluded. The study range did not include houses of bigger areas because outdoor water consumption behavior and requirements for acreage houses may follow different consumption patterns.
- Annual Trend (Y): To measure the trend over years, a new variable for the years was added. Values used were 1 for 2004, 2 for 2005, etc.

- Rainfall (R): Total rainfall in millimeters for the months of June and July individually from 2004 to 2012.
- Temperature (T): Average maximum temperature for the months of June and July individually from 2004 to 2012.
- Education (E): Education index for every neighborhood as explained earlier (see equation 2) using value ranges from 0.0 to 1.0. The information was taken for the year 2011 education data. For each neighborhood education index is constant across all years.
- Income (I): Average income level per household in Canadian dollars per year for every neighborhood. The value chosen was average income per neighborhood for the year 2011 income data. For each neighborhood annual income value is constant across all years.
- Neighborhood (N): Dummy variable representing neighborhoods. In the panel data model all neighborhoods were represented, see **Figure 8** for City of Saskatoon neighborhoods.

The general equation for the panel data is expressed as follows:

$$WC_{ijklt} = a_n + b_{n1}(P_l) + b_{n2}(H_i) + b_{n3}(Y_t) + b_{n4}(T_k) + b_{n5}(R_k) + b_{n6}(I_j) + b_{n7}(E_j) \quad (5)$$

Where: i = household; there are 46,526 houses;

j = neighborhood; there are 50 neighborhoods;

k = month from June and July 2004 to 2012 (18 variables);

t = year; time span is 9 years;

l = policy, whether mandated water restrictions are in effect (1) or not (0).

The following regression models were estimated:

Step 1: Determine whether there is a policy response for the water mandate issued during June and July 2011. The following equation was estimated:

$$WC_{ijklt} = a_1 + b_{11} (P_l) \qquad (5\text{-}1)$$

Step 2: Determine if there is policy response after controlling for lot size. Regression analysis was conducted between WC as dependent variable and policy (P) and lot size (H) as independent variables. The following equation was estimated:

$$WC_{ijklt} = a_2 + b_{21} (P_l) + b_{22} (H_i) \qquad (5\text{-}2)$$

Step 3: Determine if there is policy response after controlling for lot size and annual water saving trend. Regression analysis was conducted between WC as dependent variable and policy (P), lot size (H), and yearly trend from 2004-2012 (Y) as independent variables. The following equation was estimated:

$$WC_{ijklt} = a_3 + b_{31} (P_l) + b_{32} (H_i) + b_{33} (Y_t) \qquad (5\text{-}3)$$

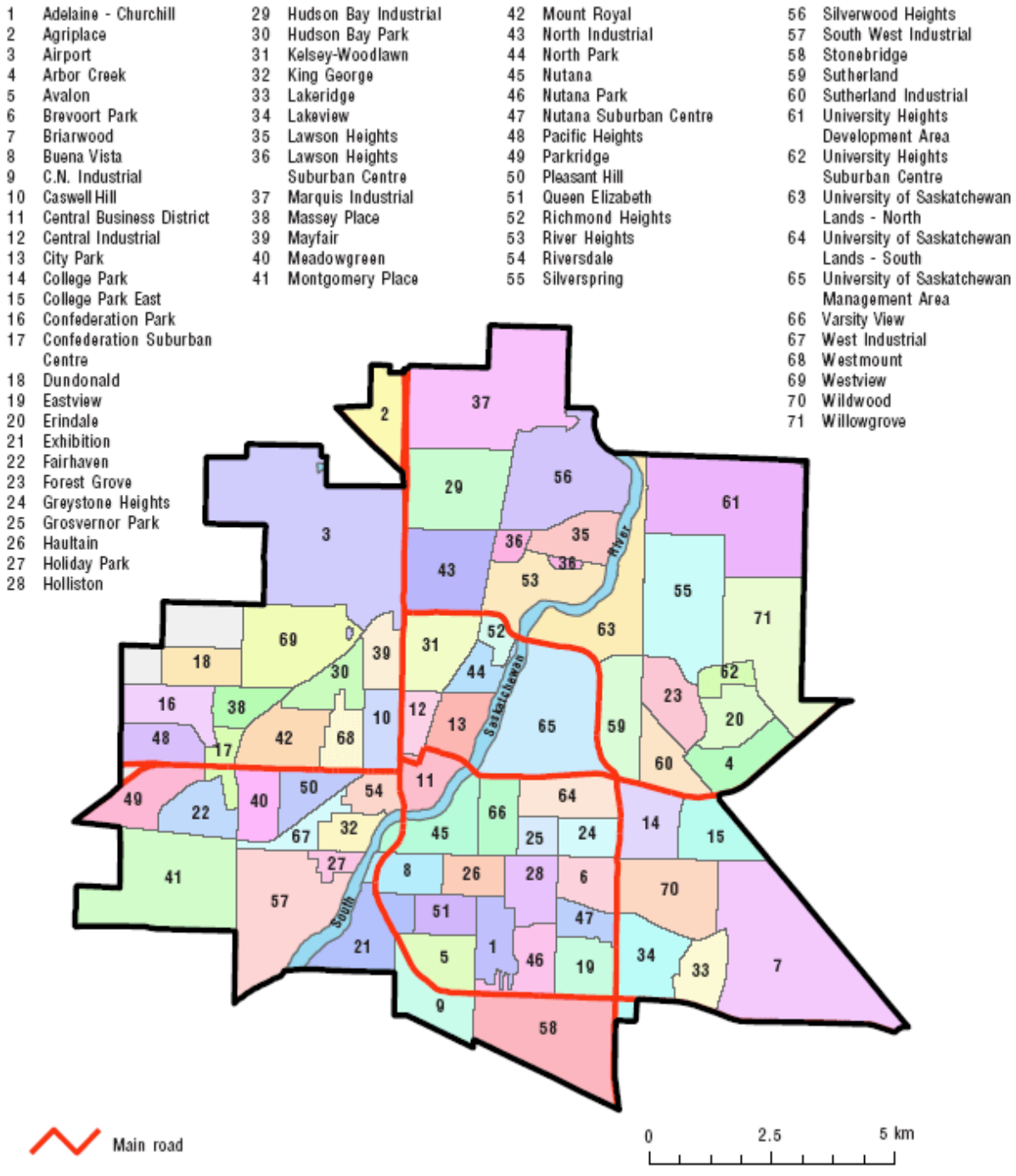
Step 4: Explore whether there is a policy response after controlling for weather independent variables (i.e., the rainfall and maximum temperature) in addition to lot size and annual trend. The following regression relation was estimated:

$$WC_{ijklt} = a_4 + b_{41} (P_l) + b_{42} (H_i) + b_{43} (Y_t) + b_{44} (T_k) + b_{52} (R_k) \qquad (5\text{-}4)$$

Step 5: Explore whether there is policy response after controlling for education and income. The following equation was estimated:

$$WC_{ijklt} = a_5 + b_{51}(P_l) + b_{52}(H_i) + b_{53}(Y_t) + b_{54}(T_k) + b_{55}(R_k) + b_{56}(E_j) + b_{57}(I_j) \quad (5\text{-}5)$$

All the regression results are shown in **Table 5**.



Source: Statistics Canada 2008

Figure 8: City of Saskatoon neighborhoods map

Table 5: Regression coefficients between water consumption, lot size, policy, annual trend, temperature, rainfall, income, and education (June, July) (Model I)

Dependent Variable: WC at June and July (ft^3 per household per month) values 100 to 10,000 ft^3.
Independent Variables: Policy (1, 0), lot size (m^2) <4047 m^2, annual trend (1, 2, 3...), temperature (^0C), rainfall (mm), income ($1,000), and education index (0.0 to 1.0).

Independent variables	Step 1	Step 2	Step 3	Step 4	Step 5
a	954.8 (1154.0)	558.1 (226.3)	741.4 (258.9)	1024.4 (82.9)	827.0 (65.9)
b_1 Policy	-158.4 (-63.7)	-158.3 (-64.8)	-24.1 (-9.1)	-34.4 (-12.9)	-34.5 (-13.1)
b_2 Lot size (m^2)		0.67 (170.4)	0.67 (172.0)	0.67 (172.4)	0.58 (148.1)
b_3 Annual trend			-39.7 (-122.8)	-38.2 (-117.8)	-38.3 (-119.2)
b_4 Temperature (^oC)				-6.4 (-14.7)	-6.5 (-14.9)
b_5 Rain (mm)				-1.6 (-55.6)	-1.6 (-56.3)
b_6 Income ($1,000)					4.5 (126.7)
b_7 Education					-316.9 (-40.0)
R^2	0.005	0.38	0.055	0.060	0.079

All a, b_1, b_2, b_3, b_4, b_5, b_6, and b_7 are significant for p = 0.05
All regressions are significant at p=0.05
N = 835,212
The numbers between brackets are t statistics

The results of the regression show that with the inclusion of seven explanatory variables 8 % of the variation in water consumption can be explained by a combination of the independent variables. The results show that the mandatory restrictions had the effect of reducing water consumption by approximately 34.5 ft^3 every month when holding lot size, annual trend, climate variables, and socio-economic variables constant. The large size of the policy coefficient in the

initial model probably accounted for the annual trend toward lower consumption. Once this trend is accounted for, there is a decline to only 34.5 ft^3 associated with the policy variable.

The amount of saving per month that resulted from the policy lasted for about one month and covered parts of June and July 2011 (June 13 to July 11, 2011). Knowing that the outdoor water consumption of the City of Saskatoon is 15.5 k gal per year in 2011 (see **Table 1**), the outdoor consumption was assumed to be spread over five months:

Total outdoor consumption = 15.5 k gal per year;

Number of summer months = 5 months;

Outdoor consumption per month = 15.5 ÷ 5 = 3.1 k gal (413.6 ft^3);

Percentage of outdoor consumption saving as a result of the policy = (34.5 ft^3 × 2)* ÷ 413.6 ft^3 = 0.167 or 17% (this means that 17% of outdoor water consumption was reduced due to policy);

Percentage of total consumption saving as a result of the policy = (34.5 × 2)* ÷ 751 ft^3 (for 2011) = 0.092 or 9% (9% total water consumption reduction due to policy);

* The policy impact of the policy was doubled as the span of policy was about half a month for June and July.

MODEL II

Each neighborhood was tested individually to explore it and determine if there is a policy response at neighborhood level for different levels of education, income or lot size.

$$WC_{ijklt} = a_6 + b_{61}(P_l) + b_{62}(H_i) + b_{63}(Y_t) + b_{64}(T_{k)} + b_{65}(R_{k)} \quad \text{(for every neighborhood alone)} \quad (6)$$

This equation will result in 50 regressions carried out separately for every neighborhood. The results of the analysis for every neighborhood is summarized in **Appendix C**.

The results at individual neighborhoods depicted different levels of policy response to the citywide mandates. Most neighborhoods (28 neighborhoods) showed insignificant policy response. A few of them (4 neighborhoods) showed negative policy response, and 18 neighborhoods showed positive policy response (responsiveness to the policy) at various level of responsiveness from − 144.9 ft^3 per month at Confederation Park (moderately old out of core neighborhood with low income) to − 6.5 ft^3 per month at Forest Grove (new out of core neighborhood with higher income). Four neighborhoods showed negative policy response from 5.5 ft^3 per month at Arbor Creek (new and high income neighborhood) to 68.4 ft^3 per month at West Mount (core neighborhood with low income), the analysis of the results will be discussed in detail in the next section.

MODEL III

One regression was run in this model, each neighborhood was given a dummy variable and tested for the policy response to explore if there was a policy response at each neighborhood for different levels of education, income, or lot sizes. The general equation was:

$$WC_{ijklt} = a_{71} + a_{72}\,(N_j) + b_{73}\,(P_t) + b_{74}\,(P_t)\,(N_j) + b_{75}\,(H_i) + b_{76}\,(Y_i) + b_{77}\,(T_k) + b_{78}\,(R_k) \qquad (7)$$

The results of the analysis for every neighborhood is summarized in **Appendix D**.

The results at neighborhood levels considering dummy variables for each neighborhood also showed different levels of policy response, the default neighborhood was Montgomery Place. Most neighborhoods (28 neighborhoods) showed positive policy response (reduction of WC in

response to the policy), meaning that the conservation mandates of 2011 resulted in a decrease in water consumption at different levels on most neighborhoods; one neighborhood showed almost no policy response, and 21 neighborhoods showed negative policy coefficient. The policy coefficient had a wide range of responsiveness from −202.9 ft^3 per month at Massey Place (a moderately old out-of-core neighborhood with relatively low income) to +180.2 ft^3 per month at Mayfair (an older neighborhood with similar income level). The discussion and analysis of the results will be discussed in detail in the next section.

CHAPTER 6

POLICY RESPONSE

To understand the policy and explore its effectiveness, we have to look more deeply into the characteristics of the water restriction issued by the City of Saskatoon during summer of 2011:

- The duration of the policy was short. The first City release was issued on June 13, 2011, and ended on July 11, 2011. The whole period for this water restriction was only 30 days (City of Saskatoon releases). Although short policy periods in water restriction could be more effective than long ones, the duration of the water restriction was so short that development of its own influence was limited and quite hard to measure.

- This water restriction was a reaction towards an urgent event of increased water turbulence that was not part of previous water education campaigns. Thus, the public had little investment in the issue and was ill prepared to respond when asked. The effectiveness of any water restriction policy increases if it can be anticipated and if people have knowledge about the problem and its public significance.

- Water restriction started as a voluntary action to reduce outdoor water use, but then changed to a mandatory regulation with a fine. This reduced the period of mandatory water restriction policy and further shortened the most effective part of the policy.

- The reason for the water restriction that was communicated to the public. It did not communicate a sense of a permanent or structural problem despite the fact that the 1906 water treatment plant was stressed to the limit in the face of an unexpected problem. Saskatoon residents believed that this event was temporary and cyclical and presented no

danger to everyday life. Although it is a good idea to provide the public with a detailed and accurate picture of the problem at hand, it is unrealistic to expect significant public response to a technical and short-term issue like turbidity. Awareness of the event was spread on local media and city releases on Internet every day, although Saskatoon residents were trying to comply with the restrictions, the message may not have reached to some citizens at the individual level, especially in light of the short period and nature of the event.

- The event cause was a local event with little regional, national or global significance. Thus, the population was unable to use the background information they may have had to relate the turbidity problem to water conservation messages they may have received. Many people have some background knowledge about global issues and will consider events in the larger context of water security problems they are aware of.

- The event nature and timing was not accompanied by a severe weather condition such as high wind speed, extreme hot weather, flood, or drought, the researcher referred to weather records and interviewed some of Saskatoon residents to see if there was abnormal weather condition. Events associated with harsh conditions attract more attention, and people usually behave in a more responsive manner to instructions and regulations. A comparable study using two locations in Australia (Darwin with a water surplus and Mallee with an extended period of drought) found significant differences in attitude and participation between the two areas. Significantly more people from Mallee, the water scarce location, were more supportive of most water conservation behaviors and more likely to state that they participated in those behaviors (Gilberston. et al 2011).

- The event was unique in the sense that it was the first time the City of Saskatoon experienced substantial reduction in the filtration capacity of its water treatment plant, at least to the researcher's knowledge. Citizens had not faced similar events before. Thus, normal people were not familiar and less prepared, and city officials were less experienced in dealing with an event of this magnitude. In retrospect, it may have been naïve to expect widespread public response to an event that was so unique and difficult to explain to the lay public.

- The problem of reduced water filtration capacity did not occur because the normal capacity of the treatment plant was unable to meet an abnormal peak demand. Instead, the event happened because plant capacity was reduced. It appears that the public was not prepared for an exceptional breakdown in supply—for unreliability in a system that is assumed to be reliable.

Although the response was not strong, there was a significant relationship between the water restriction and consumption. There was an average reduction of about 69 ft^3 in water use for both June and July 2011. The correlation of the regression was (R^2 = 0.079 for the panel data and 0.10 at neighborhood levels Model III). Even with all the uncertain variability in the data set, the short time of the policy, and less education to the population, there was a weak but statistically significant response to the mandated restrictions. The figure of - 69 ft^3, gives the City an estimate of how much reduction might be expected to occur if similar mandates were implemented or it provides a baseline for the impacts on targeted and anticipated event.

Lot size had a relatively weak but statistically significant relationship with water use. Every 1.0 m^2 reduction in lot size will result in a reduction of approximately 0.67 ft^3 during June and July

in Model I and 0.54 ft^3 per square in Model III, Model II showed various coefficients from 1.2 ft^3 per square meters in Avalon (an average lot size neighborhood) to 0.1 ft^3 at Montgomery Place (neighborhood of the largest size) and a negative relationship at Pleasant Hill (core neighborhood, low income and small lot size).

The annual declining trend in water consumption probably results from increasingly efficient water fixtures, which may be more applicable to indoor water use. Although there is currently a reduction of monthly water consumption of about 35 ft^3 in in Model I and 38 ft^3 in Model III every year, this trend is expected to flatten in this decade when most houses will be equipped with those fixtures (City of Saskatoon Annual Report 2012). Model II showed variable annual trends values. **(Appendix C).**

The impact of weather factors (temperature and rainfall) was used to control for climate condition and was significant but small in reducing outdoor water use. The amount of water required for lawn watering depends on net evapotranspiration (net ET), which is the sum of evaporation and plant transpiration (De Oreo et al 1999). This amount depends on air temperature, among other factors. Effective rainfall was assumed to be 80 percent of the total rainfall for a given day. If effective rainfall exceeded the calculated ET for any given day, the ET was set to zero (De Oreo et al 1999). People usually apply water differently from the theoretical requirements of the turf. In this case, if rain falls heavily in a short period of time, it will not be counted in the net ET and then will not effectively reduce the amount of water needed for the turf. Compounding this is the fact that people do not react to weather conditions (especially to the temperature) and do not change their lawn gardening behavior. They tend to use other subjective measures, and many of them have preprogrammed sprinkler systems for irrigation regardless of the weather.

Socio-economic factors showed that for every CAN$1000 extra annual household income water consumption increased by about 4.5 ft^3 per month. The relationship with the education level was the opposite: controlling for other factors, more educated people consumed significantly less water than less educated people.

The policy response showed large variation in its strength in Model II at the neighborhood level from the maximum value of − 144.9 ft^3 per month in Confederation Park (a medium age neighborhood with big household size) to − 6.5 ft^3 per month at Forest Grove (relatively new neighborhood with big household size). Five neighborhoods experienced an average increase in consumption from 5.5 ft^3 per month in Arbor Creek (a new out of core neighborhood with high income and large lot sizes) to 68.4 ft^3 per month in Westmount (a relatively old low income core neighborhood with low education index); probably the absence of policy response is due to high income per capita in two neighborhoods and low education level in the other three. Similar results showing a wider range of neighborhood responsiveness arose from Model III; 28 neighborhoods showed positive response to the policy and 22 neighborhoods did not, the maximum response to the policy was - 202.9 ft^3 at Brairwood (high income, out of core new neighborhood with big household size) and the minimum was at Kelsey-Wood Lawn with +180.2 ft^3 (a low income older neighborhood) See **Appendix D** for the details of policy coefficients for Model III.

There is a difference of about 60.2 % between the policy coefficients in Model II and Model III, the reason of the difference is that in Model II there was individual control factors (lot size, trend and weather) for each neighborhood, the main impact is the from the annual trend which was slower in old neighborhoods (or very new neighborhoods where the water saving fixtures are installed during house construction) that made the policy response smaller in Model III for those

neighborhoods, the opposite is for faster annual trend rate; in general, both Model II and Model III showed similar results of level and direction of responsiveness for almost all neighborhoods .

I tried to make regression for Model III by using interaction effect between policy and socio-economic factor, but the results were not statistically significant; in Model II regression for policy response as dependent variable with other socio-economic factors as independent variables were also statistically insignificant.

To get some explanation of the results through the neighborhoods, policy coefficients were arranged in descending order and presented with socio-economic factors (education, income and household size), average lot size and age of dwelling that were colored as follows for both models II and model III (see T**ables 8** and **9**):

• Education Index:	Light blue	up to 0.39 (low)
	Medium blue	from 0.4 to 0.49 (medium)
	Dark blue	above 0.5 (high)
• Average lot size:	Light blue	up to 550 m^2 (small)
	Medium blue	from 551 m^2 to 640 m^2 (medium)
	Dark blue	above 641 m^2 (large)
• Average income/household:	Light blue	up to CAD$ 75,000 (low)
	Medium blue	from CAD$ 75,001 to CAD$ 85,000 (medium)
	Dark blue	above CAD$ 85,000 (high)

• Household size:	Light blue	up to 2.5 (low and average)
	Medium blue	from 2.6 to 2.9 (above average)
	Dark blue	above 2.9 (big)
• Income per capita:	Light blue	up to CAD$ 30,000 (low)
	Medium blue	from CAD$ 30,001 to CAD$ 40,000 (medium)
	Dark blue	above CAD$ 40,000 (high)
• Age of dwelling	Light blue	up to 39.9 years (new)
	Medium blue	from 40.0 to 49.9 years (medium)
	Dark blue	above 50.0 years (old)

For Model II (**Table 6**), the highest two policy responses were in Confederation Park and Pacific Heights both have low education index. The reason of weak relationship between education index and the policy strength could be due to short notice and the unplanned nature of the water mandate, which was not preceded nor accompanied by an effective awareness campaign.

Neighborhoods with larger lot sizes were scattered within different levels of policy response strengths. Montgomery Place, which has distinguished large average lot size, showed a comparatively high policy response, the impact of the policy of higher lots are more noticeable because of the high outdoor percentage associated with larger lots.

Average income per capita showed a better representation of policy response level than the average income per household. The income per capita is more accurate representative of the family wealth and life standards. The two top average income per capita neighborhoods (Arbor Creek and Erindale) did not show a positive response to the policy although they have big lot sizes. They are

also geographically close to each other away from the core neighborhoods. Nutana a core neighborhood, which is the third ranking neighborhood in terms of income per capita, showed positive but moderate response to the policy. Low income per capita level was associated in the highly responsive neighborhoods in general, except for Wesmount (a core neighborhood with small lot size). This suggests that high income people are less responsive to water mandates for all the reasons stated in the literature; they are oblivious to price, fines, and have a large stake in the value of their property.

Neighborhoods with a large number of people permanently living have showed more responsiveness to the policy (except for Erindale and Arbor Creek which have high average income per capita). I believe that higher policy response is because that households with more residents are more cooperative and have greater awareness of public issues.

Table 6: Policy response for different neighborhoods analyzed separately with socio-economic factors, lot size and dwelling age (Model II)

No.	Neighborhood	b_1 policy	Education index 2006	Average lot size (m^2)	Average income per house 2011 (CAD $)	Household size (person per house)	Income per capita (CAD$)	Dwelling age (year)
11	Confederation Park	-144.9	0.33	469.4	70,991	2.9	24,480	40.0
37	Pacific Heights	-139.8	0.24	548.3	83,024	3.1	26,782	41.0
4	Brevoort Park	-138.6	0.43	612.7	75,113	2.4	31,297	46.5
38	Parkridge	-104.1	0.3	648.4	86,736	3.1	27,979	33.6
32	Montgemry Place	-102.8	0.42	1258.8	102,865	2.9	35,471	50.5
49	Westview	-92.9	0.3	574.2	79,326	2.9	27,354	39.9
12	Dundonald	-80.3	0.34	574.3	84,325	3	28,108	29.5
47	Varsity View	-77.5	0.62	586.3	71,939	2	35,970	49.6
16	Fairhaven	-77.1	0.32	630.5	67,827	2.7	25,121	40.9
31	Meadowgreen	-73.8	0.29	584.6	59,540	2.6	22,900	45.2
20	Haultain	-71	0.55	508.1	82,356	2.1	39,217	62.3
18	Greystone Heights	-67.8	0.59	632	80,830	2.5	32,332	48.6
50	Wildwood	-52.6	0.51	829.3	70,435	2.2	32,016	32.1
3	Avalon	-50.9	0.49	614.6	89,367	2.4	37,236	58.4
35	Nutana	-50.4	0.65	525.7	83,739	2	41,870	52.0
6	Buena Vista	-45.9	0.58	451.8	82,342	2.2	37,428	59.9
40	Queen Elizabeth	-44.5	0.42	695.3	70,287	2.4	29,286	62.7
17	Forest Grove	-6.5	0.43	593	89,349	2.7	33,092	34.9
2	Arbor Creek	5.5	0.59	669.8	161,882	3.2	50,588	14.7
14	Erindale	20.1	0.49	666.5	147,048	3.1	47,435	25.6
13	Eastview	41.1	0.48	619.3	77,095	2.5	30,838	46.4
48	Westmount	68.4	0.32	472.3	57,488	2.5	22,995	57.7

All policy responses above are p = 0.05

For model III, policy responses are statistically significant for all neighborhoods.

Looking at the education index spectrum, similar to Model II, there is no clear relation between education index and policy response strength. As stated earlier, that could be due to short notice and the unplanned nature of the water mandate which was not preceded nor accompanied by an effective awareness campaign.

Larger lot sizes neighborhoods were scattered within different levels of policy response strengths. It is to be noted that Montgomery Place, which has distinguished high average lot size, also showed comparatively high policy response similar to Model II.

Average income per capita did not show a trend of policy response level as appeared in Model II. The two top average income per capita (Arbor Creek and Brairwood) showed no response to the policy, in spite of having big lot sizes.

Neighborhoods with high number of people permanently living have showed more responsiveness that matches with similar finding in Model II. All neighborhoods that had negative responsiveness were of smaller size, except Arbor Creek and Silverspring.

Six out of eight core neighborhoods showed no response to the policy response, newer dwelling age showed more responsiveness to the policy; moderate and new neighborhoods have high policy coefficient except for Montgomery Park (an older neighborhood with large lot size) while older neighborhoods exhibited lower or no policy response.

Table 7: Policy response for different neighborhoods with socio-economic factors, lot size and dwelling age assuming dummy variables (Model III)

No.	Community	b1 policy	Education index 2006	Average lot size (m^2)	Average income per house 2011 ($)	Household size* (person per house)	Income per capita (CAN$)	Dwelling age (year)
29	Massey Place	-202.9	0.34	559.8	64,500	2.7	23,888.9	46.1
11	Confederation Park	-196.6	0.33	469.4	70,991	2.9	24,479.7	40.0
12	Dundonald	-191.5	0.34	574.3	84,325	3	28,108.3	29.5
32	Montgemry Place	-182.5	0.42	1258.8	102,865	2.9	35,470.7	50.5
4	Brevoort Park	-146.4	0.43	612.7	75,113	2.4	31,297.1	46.5
37	Pacific Heights	-137.8	0.24	548.3	83,024	3.1	26,781.9	41.0
19	Grosvenor Park	-136.9	0.68	839.4	76,510	2.2	34,777.3	49.7
38	Parkridge	-124.9	0.3	648.4	86,736	3.1	27,979.4	33.6
27	Lakeview	-111.5	0.58	612.1	99,644	2.7	36,905.2	33.5
28	Lawson Heights	-94.1	0.54	654	105,977	2.6	40,760.4	39.9
50	Wildwood	-92.1	0.51	829.3	70,435	2.2	32,015.9	32.1
45	Silverwood Heights	-80.6	0.46	613.6	110,502	3	36,834.0	33.4
26	Lakeridge	-80.4	0.53	626	149,124	3.3	45,189.1	27.3
18	Greystone Heights	-80.4	0.59	632	80,830	2.5	32,332.0	48.6
16	Fairhaven	-78.1	0.32	630.5	67,827	2.7	25,121.1	40.9
31	Meadowgreen	-63.3	0.29	584.6	59,540	2.6	22,900.0	45.2
3	Avalon	-62.3	0.49	614.6	89,367	2.4	37,236.3	58.4
21	Holiday Park	-54.6	0.36	676.3	58,867	2.3	25,594.3	53.2
20	Hautain	-49.9	0.55	508.1	82,356	2.1	39,217.1	62.3
25	King George	-46	0.19	470.4	47,209	2.4	19,670.4	60.2
14	Erindale	-43.7	0.49	666.5	147,048	3.1	47,434.8	25.6
42	River Heights	-40.3	0.53	729.4	107,216	2.5	42,886.4	44.0
40	Queen Elizabeth	-36.8	0.42	695.3	70,287	2.4	29,286.3	62.7
47	Varsity View	-35.9	0.62	586.3	71,939	2	35,969.5	49.6
49	Westview	-34.5	0.3	574.2	79,326	2.9	27,353.8	39.9
1	Adelaide/Churchill	-29.4	0.47	691.1	93,506	2.6	35,963.8	58.7
17	Forest Grove	-18.6	0.43	593	89,349	2.7	33,092.2	34.9
22	Holliston	-6.5	0.5	723.7	89,179	2.3	38,773.5	55.6
6	Buena Vista	0	0.58	451.8	82,342	2.2	37,428.2	59.9
10	College Park East	15	0.4	568.7	82,039	2.7	30,384.8	42.4
43	Riversdale	16.1	0.27	414.3	53,086	2.5	21,234.4	60.5
24	Kelsey-Wood Lawn	20.2	0.26	512.4	53,858	2.3	23,416.5	65.8
35	Nutana	21.9	0.65	525.7	83,739	2	41,869.5	52.0
41	Richmond Heights	23.4	0.43	603.4	83,676	2.3	36,380.9	46.6

No.	Community	b1 policy	Education index 2006	Average lot size (m^2)	Average income per house 2011 ($)	Household size* (person per house)	Income per capita (CAN$)	Dwelling age (year)
2	Arbor Creek	24.2	0.59	669.8	161,882	3.2	50,588.1	14.7
8	City Park	33.1	0.54	488.6	53,556	1.7	31,503.5	51.3
9	College Park	34.2	0.49	638.4	79,142	2.5	31,656.8	43.9
44	Silverspring	35.8	0.52	629.3	123,135	3.2	38,479.7	18.7
36	Nutana Park	36.4	0.48	633.3	80,681	2.7	29,881.9	50.3
13	Eastview	37.3	0.48	619.3	77,095	2.5	30,838.0	46.4
46	Sutherland	42.4	0.41	608	63,189	2.3	27,473.5	37.7
34	North Park	44.3	0.46	538.3	82,172	2.3	35,727.0	57.8
15	Exhibition	65.5	0.36	491.6	61,051	2.1	29,071.9	52.3
5	Briarwood	74.7	0.6	778.7	157,611	3	52,537.0	14.1
33	Mount Royal	81.3	0.26	658.4	52,078	2.3	22,642.6	55.4
39	Pleasant Hill	95.8	0.2	547.1	40,295	2.3	17,519.6	49.9
7	Caswell Hill	102.5	0.37	417.3	64,021	2.2	29,100.5	61.7
23	Hudson Bay Park	116.1	0.37	576.7	66,015	2.2	30,006.8	55.5
48	Westmount	127.4	0.32	472.3	57,488	2.5	22,995.2	57.7
30	Mayfair	180.2	0.34	489.4	69,559	2.4	28,982.9	57.1

Models II and III showed different coefficients of policy responses; the difference came from averaging the control variables in Model III, the most important and effective one is the annual trend, if an individual neighborhood has higher annual trend (in absolute value) in model II than the annual trend in Model III that will reduce policy strength and the opposite happens when the trend is lower than the average. The differences between statistically significant policy responses are shown in **Appendix E**. Nineteen neighborhoods out of 22 showed same direction of policy response; the average absolute difference is 34.5 ft^3.

In evaluating any policy, we should know whether policy targets have been attained. Compliance with government policies varies tremendously across policies (Weaver 2009). In some cases, it seems that compliance with government policies is hardly observed at all, but non-

compliance by citizens is actually the exception to the rule. In fact, in many cases, the compliance rate for government policies is surprisingly high (Weaver 2009).

First, I will define the target compliance. The definition of compliance by Oxford dictionary is the "The action or fact of complying with a wish or command" or "The state or fact of according with or meeting rules or standards" (Oxford Dictionary). Compliance may, but need not, involve willing agreement to behave in this way. Grudging compliance is still compliance (Weaver 2009).

It is not practical for a policymaker to expect full compliance with any policy especially in a policy intended to change people behavior towards their lawn irrigation which is considered part of homeowner personality. An "adequate" level of compliance is good enough to indicate whether a policy has not failed. Let us assume that all the citizens were in full compliance to the water mandate issued in June and July 2011, and they stopped their outdoor water consumptions completely as instructed by the City of Saskatoon. Let us then compare it with the policy reduction resulted from the analysis. As stated earlier, the percentage of compliance to outdoor consumption is 17 %. Can we consider this percentage adequate? There is no definite answer because this matter is relative and mainly dependent on the policymaker plans and expectations, the policymaker defines the level of compliance. In cases where resources are limited – which is almost always – it is important to analyze how much compliance is "good enough" (Grindle, 2004; Grindle, 2007). From compliance level view, I would consider that any value above 30% is adequate compliance and "good enough." With the policy response of 17 %, which is almost half of the target 30% value, I can assess that there was a moderate public response to the City's call to action. From results-oriented view, the level of compliance, along with complete shutdown of public parks irrigation, reduced the total amount of the City consumption to a level that was sufficient to

maintain a steady water supply to residential customers. Due to the short time of the water mandate, it was difficult to establish a structure of sanctions (or incentive) and monitor compliance "to ensure that compliance is appropriately rewarded and that noncompliance punished" (Weaver 2009).

If we look at the compliance indicator at neighborhood level, there a wide spectrum of compliance levels (from + 68.4 to − 144.9 ft^3 per month in model II and from + 180 ft^3 per month to − 203 ft^3 per month in model III). This will give a lesson to a policymaker that he should not assume "that targets are homogeneous and that strategies to secure compliance from the 'modal' client will work for all" (Weaver 2009).

From the level of compliance in different neighborhoods, we should learn that social groups respond differently to policy mandates and public messaging. Rather than assume that the policy was wrong, it makes more sense to dissect people and places that are uncooperative and think through alternative ways to connect with them. It is too easy to conclude that there is something wrong with the policy or wrong with the targets.

The results of the analysis in comparison with the hypotheses set earlier are summarized in **Table 8**.

Table 8: Hypotheses results

No.	Hypothesis	Analysis range	Results	Comments
Hypo. 1	Saskatoon residents restricted their WC in response to City's water rationing	Whole city Model I	Significant for p = 0.05 R^2 = 0.08 compliance is 17% of full compliance	Low level of explanation, partially to successful policy.
Hypo. 2a	Households of bigger lots have higher WC	Whole city Model I	Significant for p = 0.05 R^2 = 0.08 b = 0.58	Low level of explanation. There is a positive relationship between WC and lot size.
Hypo. 2b	Water rationing policy has bigger impact for higher lots	Comparison between neighborhoods Models II & III	Not clear	Hypothesis not proven.
Hypo. 3	Water rationing policy is more effective for highly educated neighborhoods	Comparison between neighborhoods Models II & III	Not clear	Hypothesis not proven.
Hypo. 4	Water rationing policy is less effective for high income neighborhoods	Comparison between neighborhoods Models II & III	Can be noticed from neighborhood responses level	Hypothesis showed slight evidence through neighborhoods response levels for income per capita.

CHAPTER 7

LIMITATIONS AND COMMENTS

Because residential water meters are not read on a monthly basis, the meter readings included in the data reflect pro-rated consumption between the actual meter read date for the month and the last day of the month. When actual meter readings are not available, the City estimates consumption for a particular period based on previous consumption history (Yobb, Twyla personal communication, August 11, 2014). Moreover, readings are adjusted at the end of the year and, therefore, the December figures are artificially inflated by this process (Yobb, Twyla personal communication, August 11, 2014).

Adjustments made to water consumption readings with some readings reduced to 0.0 ft^3 per month and other very high readings of more than five times the average may cause inaccurate and sometimes misleading relations. Additionally, there are large differences in household readings. Observations larger than 10,000 ft^3 per month and smaller than 100 ft^3 per month were deleted from the data set.

Average maximum monthly temperatures and monthly rainfall may not be the most appropriate indicators to estimate the landscape's need for irrigation and garden watering sequencing and amount. In addition there is significant variation within individual months that can affect consumption, that variation was not counted for in the monthly estimate. Furthermore, information about weather conditions is available for the city as a whole and does not allow consideration of the differences in rainfall amounts on different regions within the city.

The short span of readings records of nine years also makes number of available observations too small to capture inter - annual summer variation in use, especially at the neighborhood level. . The policy incident itself was limited to less than one month in the summer of 2011, making it difficult to generalize this one event to water conservation experiences and messaging. Education index is not the only factor that reflects the level of awareness and responsiveness. An ethnic diversity factors could inhibit people for whom English is a second language from hearing the message to reduce outdoor use. This factor is gaining more importance with the increased cultural diversity of the City of Saskatoon population.

Education index and annual income are very coarsely defined. They address each neighborhood as one unit. Increased accuracy in results could be obtained if these factors were assessed per individual household.

The unit of measurement of water consumption, annual income, and education index were estimated per household. Variations exist in the size of the households within the neighborhoods, ranging from 1.7 to 3.3 persons per house. The amount of indoor water use might be affected by the number of people permanently living in one house, but outdoor water use was considered to be less affected by household size.

CHAPTER 8

RECOMMENDATIONS

This study of the effectiveness of policy mandates to reduce outdoor water use contains messages about public response that can be applied to future similar events. First, the policy is useful to gaining an emergency reaction or achieving an immediate action to a sudden event such as an extreme weather event or mechanical failure. People may, however, behave differently if the need for conservation lasts for longer time.

Second, the modest negative relationship between lot sizes and outdoor water consumption suggests to urban planners that reducing lot size or irrigable area can influence per household water consumption and that a denser urban setting is one avenue to control outdoor water use. Third, the downward trend in per capita water consumption can provide a short-term buffer from drought and infrastructure problems, but is unlikely to provide a long-term structural solution to meeting urban water demand because there is a point when all indoor efficiencies will be achieved. The City will then face increased demand to match its growing population, and a new strategy will be needed to accommodate growth. Fourth, the City needs a comprehensive emergency plan to adjust to a sudden drop of pumping or filtering capacity. This plan must contain awareness campaigns, effective incentive and sanction policy, a monitoring system, and contingencies such as additional reservoirs.

The main problem is to curb the City's peak summer demand which is driven by land use patterns, deep-seated cultural preferences for lawns and pools, and little experience with water

conservation campaigns. Future policy(s) should therefore focus on a sustainable long term policy to reduce outdoor water consumption.

One important component of this policy is the capacity to measure and monitor outdoor water use. Currently, the City of Saskatoon has its own method of conducting water meter reading which is inaccurate in representing household consumption. For monitoring and research purposes, the City needs detailed knowledge about consumer behaviors and their patterns of consumption for various levels of income, education level, and at different times of the year. The City could select random housing units for more frequent and regular readings; these readings will indicate average consumption levels, leakage problems, and enable future studies of water conservation. Should the City want to use mandated restrictions in the future, it will need a much better system of billing and monitoring to measure the policy's effectiveness in reducing peak-month consumption.

CHAPTER 9

CONCLUSION

In closing, the question still to be answered is to what extent people will change their behaviors when faced with a water supply problem? Although this study focused on a turbidity problem at the water treatment plant, it provides larger insights into how people respond to public messages about the need for water conservation. A relevant issue for policymakers is how much change in behavior can be expected in response to messaging about the need for water conservation. From this research, we can say that Saskatoon residents responded to the 2011 water mandate, but their response was limited in size, variable in level of response in terms of socio-economic status, and geographic scope.

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APPENDIX A

Saskatoon neighborhoods education, average lot sizes, average income, population, household size, SDA and dwelling age

No.	Community	Education index 2006	Average lot size (m^2)	Average income per house 2011 ($)	Population 2011	Household size* (person per house)	SDA	Dwelling ** age (years)
1	Adelaide/Churchill	0.47	691.1	93,506	3,325	2.6	Nutana	58.7
2	Arbor Creek	0.59	669.8	161,882	5,050	3.2	University Heights	14.7
3	Avalon	0.49	614.6	89,367	3,335	2.4	Nutana	58.4
4	Brevoort Park	0.43	612.7	75,113	3,435	2.4	Nutana	46.5
5	Briarwood	0.60	778.7	157,611	5,010	3.0	Lakewood	14.1
6	Buena Vista	0.58	451.8	82,342	3,195	2.2	Nutana	59.9
7	Caswell Hill	0.37	417.3	64,021	3,530	2.2	Core	61.7
8	City Park	0.54	488.6	53,556	4,420	1.7	Core	51.3
9	College Park	0.49	638.4	79,142	5,380	2.5	Lakewood	43.9
10	College Park East	0.40	568.7	82,039	4,505	2.7	Lakewood	42.4
11	Confederation Park	0.33	469.4	70,991	6,680	2.9	Confederation	40.0
12	Dundonald	0.34	574.3	84,325	5,165	3.0	Confederation	29.5
13	Eastview	0.48	619.3	77,095	3,710	2.5	Nutana	46.4
14	Erindale	0.49	666.5	147,048	4,200	3.1	University Heights	25.6
15	Exhibition	0.36	491.6	61,051	2,595	2.1	Nutana	52.3
16	Fairhaven	0.32	630.5	67,827	4,370	2.7	Confederation	40.9
17	Forest Grove	0.43	593.0	89,349	5,610	2.7	University Heights	34.9
18	Greystone Heights	0.59	632.0	80,830	2,425	2.5	Nutana	48.6
19	Grosvenor Park	0.68	839.4	76,510	1,515	2.2	Nutana	49.7
20	Hautain	0.55	508.1	82,356	2,955	2.1	Nutana	62.3
21	Holiday Park	0.36	676.3	58,867	1,585	2.3	Confederation	53.2
22	Holliston	0.50	723.7	89,179	3,410	2.3	Nutana	55.6
23	Hudson Bay Park	0.37	576.7	66,015	2,155	2.2	Confederation	55.5
24	Kelsey-Wood Lawn	0.26	512.4	53,858	1,055	2.3	Lawson	65.8
25	King George	0.19	470.4	47,209	1,825	2.4	Core	60.2
26	Lakeridge	0.53	626.0	149,124	3,800	3.3	Lakewood	27.3

27	Lakeview	0.58	612.1	99,644	7,225	2.7	Lakewood	33.5
28	Lawson Heights	0.54	654.0	105,977	4,715	2.6	Lawson	39.9
29	Massey Place	0.34	559.8	64,500	3,410	2.7	Confederation	46.1
30	Mayfair	0.34	489.4	69,559	2,535	2.4	Lawson	57.1
31	Meadowgreen	0.29	584.6	59,540	4,165	2.6	Confederation	45.2
32	Montgemry Place	0.42	1258.8	102,865	2,525	2.9	Confederation	50.5
33	Mount Royal	0.26	658.4	52,078	4,405	2.3	Confederation	55.4
34	North Park	0.46	538.3	82,172	2,130	2.3	Lawson	57.8
35	Nutana	0.65	525.7	83,739	6,260	2.0	Core	52.0
36	Nutana Park	0.48	633.3	80,681	2,760	2.7	Nutana	50.3
37	Pacific Heights	0.24	548.3	83,024	3,925	3.1	Confederation	41.0
38	Parkridge	0.30	648.4	86,736	4,045	3.1	Confederation	33.6
39	Pleasant Hill	0.20	547.1	40,295	4,190	2.3	Core	49.9
40	Queen Elizabeth	0.42	695.3	70,287	2,560	2.4	Nutana	62.7
41	Richmond Heights	0.43	603.4	83,676	966	2.3	Lawson	46.6
42	River Heights	0.53	729.4	107,216	4,255	2.5	Lawson	44.0
43	Riversdale	0.27	414.3	53,086	2,115	2.5	Core	60.5
44	Silverspring	0.52	629.3	123,135	5,120	3.2	University Heights	18.7
45	Silverwood Heights	0.46	613.6	110,502	10,140	3.0	Lawson	33.4
46	Sutherland	0.41	608.0	63,189	5,645	2.3	University Heights	37.7
47	Varsity View	0.62	586.3	71,939	3,795	2.0	Core	49.6
48	Westmount	0.32	472.3	57,488	2,440	2.5	Core	57.7
49	Westview	0.30	574.2	79,326	3,550	2.9	Confederation	39.9
50	Wildwood	0.51	829.3	70,435	7,335	2.2	Lakewood	32.1
	Average	**0.43**	**608.8**	**82,826**	**3,889**	**2.5**		
	Total				**194,451**			

* Average value of 2006 and 2011.

** See equation (3)

Source: Annual Report 2013

APPENDIX B

Rainfall, mean and maximum temperature (June to July) from years 2004 to 2012 with historical average

Year	Rainfall (mm)		Mean temperature (ºC)		Maximum temperature (ºC)	
	June	July	June	July	June	July
2004	88.2	95.4	13.6	17.6	19.8	25.7
2005	171	44.4	15.3	18.9	20.1	25.3
2006	105.8	39.8	16.3	21.0	22.1	27.6
2007	109.4	16.4	15.8	21.8	22.2	28.5
2008	78	80	15.9	18.6	22.7	24.7
2009	52	62	16.0	16.8	22.7	22.8
2010	147.2	94.6	16.4	18.0	21.8	24.0
2011	93	72.9	16.1	19.3	21.7	25.4
2012	92.8	98.2	16.9	20.5	22.3	26.0
All year's average	104.2	67.1	15.8	19.2	21.7	25.6
Historical average	61*	60*	16.0*	18.2*		
Average high			22.6*	24.9*		
Average low			9.4*	11.4*		

Source: weather data from SRC,

* Source: Weather network

APPENDIX C

Regression coefficients between water consumption, policy, lot size, annual trend, temperature, and rainfall at each individual neighborhood (June, July) (Model II)

Dependent Variable: WC at June and July (ft^3 per household per month) values 100 ft^3 to 10,000 ft^3.
Independent Variables: Policy (0, 1), lot size (m^2) <4047 m^2, annual trend (1, 2, 3...), temperature (^0C), rainfall (mm).

No.	Neighborhood	R^2	a	b_1 policy	b_2 lot size	b_3 annual trend	b_4 temperature	b_5 rain	N
1	Adelaide/Churchill	0.056	524.6	-6.3 (0.722)	0.71	-44.7	16.3	-1.9	19,734
2	Arbor Creek	0.091	-290.0	5.5	1.1	-31.0	45.6	-1.6	18,895
3	Avalon	0.101	-237.9	-50.9	1.2	-40.6	35.2	-1.8	17,989
4	Brevoort Park	0.063	1100.0	-138.6	0.90	-40.2	-16.0	-1.0	14,329
5	Briarwood	0.078	1134.6	27.4 (0.203)	1.1	-24.7	-17.6	-2.0	12,960
6	Buena Vista	0.028	596.0	-45.9	0.48	-23.1	-4.1	0.2 (0.187)	18,473
7	Caswell Hill	0.008	716.7	16.9 (0.262)	0.26	-11.5	-5.9	-0.64 (0.697)	17,368
8	City Park	0.048	718.7	-31.0 (0.105)	0.60	-18.4	-7.3	-0.51	11,164
9	College Park	0.051	745.7	10.0 (0.452)	0.49	-30.0	2.7 (0.226)	-0.65	20,429
10	College Park East	0.087	890.1	16.3 (0.165)	0.89	-38.2	-9.3	-1.0	21,732
11	Confederation Park	0.083	2586.2	-144.9	0.27	-54.1	-68.9	-1.1	28,192
12	Dundonald	0.112	3106.8	-80.3	0.15	-74.2	-66.9	-3.4	22,028
13	Eastview	0.073	209.2	41.1	0.87	-36.8	14.2	0.58	17,477

No.	Neighborhood	R^2	a	b_1 policy	b_2 lot size	b_3 annual trend	b_4 temperature	b_5 rain	N
14	Erindale	0.093	869.3	20.1	0.98	-57.6	7.6	-2.5	19,492
15	Exhibition	0.029	400.8	17.3	0.44	-21.8	1.6	0.68	12,314
				(0.258)			(0.521)		
16	Fairhaven	0.066	1689.8	-77.1	0.59	-41.6	-11.3	-5.2	14,766
17	Forest Grove	0.079	1666.9	-6.5	0.94	-44.1	-28.4	-3.5	22,196
18	Greystone Heights	0.052	1049.1	-67.8	0.72	-41.8	-12.3	-1.2	11,210
19	Grosvenor Park	0.094	-35.6	-73.2	0.75	-56.7	42.3	-2.5	5,392
				(0.066)					
20	Haultain	0.037	567.1	-71.0	0.61	-30.6	-0.4	0.20	17,256
							(0.890)	(0.244)	
21	Holiday Park	0.050	1282.3	-49.3	0.61	-40.5	-19.7	-2.0	7,040
				(0.088)					
22	Holliston	0.035	439.6	-12.7	0.37	-34.9	16.2	-0.79	16,829
				(0.420)				(0.257)	
23	Hudson Bay Park	0.014	548.6	17.6	0.51	-7.7	0.98	-0.24	10,216
				(0.427)			(0.789)	(0.325)	
24	Kelsey-Wood Lawn	0.014	958.9	-63.6	0.09	-13.9	-0.22	-2.0	4,863
				(0.077)	(0.197)		(0.970)		
25	King George	0.041	1439.0	-54.9	0.38	-35.9	-27.0	-1.4	10,262
26	Lakeridge	0.106	706.7	12.2	0.87	-64.5	12.3	-0.83	20,976
				(0.449)					
27	Lakeview	0.082	182.3	-57.5	0.88	-52.4	31.9	-0.83	30,841
28	Lawson Heights	0.103	1795.1	-24.8	0.76	-60.0	-28.9	-2.3	18,303
				(0.127)					
29	Massey Place	0.104	2640.1	-126.6	0.37	-62.0	-64.5	-1.9	14,195
30	Mayfair	0.016	34.7	45.5	0.55	3.7	14.7	0.30	14,531
				(0.017)		(0.111)		(0.145)	
31	Meadowgreen	0.048	994.1	-73.8	0.68	-36.2	3.1	-3.4	13,337
							(0.448)		

No.	Neighborhood	R^2	a	b_1 policy	b_2 lot size	b_3 annual trend	b_4 temperature	b_5 rain	N
32	Montgomery Place	0.104	2320.1	-102.8	0.10	-66.8	-8.7 (0.064)	-7.5	14,247
33	Mount Royal	0.006	844.4	-7.8 (0.613)	0.32	-11.1	-5.9	-0.81	23,353
34	North Park	0.036	384.1	-25.5 (0.152)	0.68	-15.9	4.2 (0.145)	-0.26 (0.178)	12,094
35	Nutana	0.060	600.2	-50.4	0.78	-16.5	-0.56 (0.830)	-1.47	21,127
36	Nutana Park	0.033	422.6	5.2 (0.733)	0.60	-27.1	11.8	-0.05 (0.756)	15,935
37	Pacific Heights	0.045	2034.8	-139.8	0.58	-40.1	-36.0	-3.3	21,139
38	Parkridge	0.085	1819.5	-104.1	0.71	-48.1	-13.8	-5.7	19,019
39	Pleasant Hill	0.01	998.7	-26.6 (0.370)	-0.30	-2.0 (0.577)	-6.2 (0.199)	-2.1	10,019
40	Queen Elizabeth	0.039	674.9	-44.5	0.49	-35.0	4.7 (0.149)	-0.84	12,400
41	Richmond Heights	0.034	567.9	-18.4 (0.527)	0.74	-25.0	-5.1 (0.293)	-1.0	4,797
42	River Heights	0.083	1474.3	-1.9 (0.898)	0.74	-50.5	-20.5	-2.2	21,422
43	Riversdale	0.019	1324.5	-37.5 (0.157)	0.35	-22.2	-25.4	0.70	7,869
44	Silverspring	0.067	776.2	9.8 (0.575)	0.66	-31.2	12.8	-2.9	18,677
45	Silverwood Heights	0.089	1801.3	-14.1 (0.149)	0.76	-58.8	-29.6	-1.9	51,823
46	Sutherland	0.022	1186.8	19.0 (0.259)	0.26	-31.1	-12.4	-0.88	15,894
47	Varsity View	0.074	-252.9	-77.5	1.0	-24.4	32.2	-1.4	15,203
48	Westmount	0.049	728.7	68.4	0.58	-19.9	-9.5	-0.43	12,064

No.	Neighborhood	R^2	a	b_1 policy	b_2 lot size	b_3 annual trend	b_4 temperature	b_5 rain	N
49	Westview	0.027	1097.9	-92.9	0.50	-19.9	-15.7	-0.12 (0.511)	18,984
50	Wildwood	0.051	646.1	-52.6	0.45	-48.7	21.5	0.22	16,604

All a, b_1, b_2, b_3, b_4, and b_5 are significant for p=0.05 except as indicated between brackets.
All regressions are significant at p=0.05.

APPENDIX D

Regression coefficients between water consumption, policy, lot size, annual trend, temperature, and rainfall at each neighborhood as dummy variable (June, July) (Model III)

Dependent Variable: WC at June and July (ft^3 per household per month) values 100 ft^3 to 10,000 ft^3
Independent Variables: policy (0, 1), lot size (m^2) <4047 m^2, annual trend (1, 2, 3...), temperature (^0C), rainfall (mm)

No.	Neighborhood	a	b_1 policy	b_2 lot size	b_3 annual trend	b_4 temperature	b_5 rain	R^2
1	Adelaide/Churchill	1122.6	-29.4	0.54 (all)	-38.2 (all)	-6.4 (all)	-1.6 (all)	0.1 (all)
2	Arbor Creek	1290.9	24.2					
3	Avalon	1104.4	-62.3					
4	Brevoort Park	1136.6	-146.4					
5	Briarwood	1268.1	74.7					
6	Buena Vista	847.7	0.0					
7	Caswell Hill	867.5	102.5					
8	City Park	915.1	33.1					
9	College Park	1052.3	34.2					
10	College Park East	1072.9	15					
11	Confederation Park	1113.4	-196.6					
12	Dundonald	1141.6	-191.5					
13	Eastview	1092.5	37.3					
14	Erindale	1305.9	-43.7					
15	Exhibition	814.6	65.5					
16	Fairhaven	1383.1	-78.1					
17	Forest Grove	1193.4	-18.6					

No.	Neighborhood	a	b_1 policy	b_2 lot size	b_3 annual trend	b_4 temperature	b_5 rain	R^2
18	Greystone Heights	1038.6	-80.4					
19	Grosvenor Park	1124.2	-136.9					
20	Haultain	901.9	-49.9					
21	Holiday Park	969.6	-54.6					
22	Holliston	998.2	-6.5					
23	Hudson Bay Park	967.6	116.1					
24	Kelsey-Wood Lawn	951.9	20.2					
25	King George	902.7	-46.0					
26	Lakeridge	1301.2	-80.4					
27	Lakeview	1291.5	-111.5					
28	Lawson Heights	1241.6	-94.1					
29	Massey Place	1037.0	-202.9					
30	Mayfair	898.0	180.2					
31	Meadowgreen	1161	-63.3					
32	Montgemry Place	1093.0	-182.5					
33	Mount Royal	909.1	81.3					
34	North Park	932.7	44.3					
35	Nutana	972.1	21.9					
36	Nutana Park	1077.8	36.4					
37	Pacific Heights	1200.5	-137.8					
38	Parkridge	1350.5	-124.9					
39	Pleasant Hill	1000.2	95.8					
40	Queen Elizabeth	990.3	-36.8					

No.	Neighborhood	a	b_1 policy	b_2 lot size	b_3 annual trend	b_4 temperature	b_5 rain	R^2
41	Richmond Heights	1072.8	23.4					
42	River Heights	1179.6	-40.3					
43	Riversdale	951.2	16.1					
44	Silverspring	1222.0	35.8					
45	Silverwood Heights	1271.3	-80.6					
46	Sutherland	968.7	42.4					
47	Varsity View	1020.9	-35.9					
48	Westmount	859.5	127.4					
49	Westview	1068.3	-34.5					
50	Wildwood	1242.0	-92.1					

All $p < 0.05$

APPENDIX E

Comparison between Model II and Model III for policy response

Neighborhood	b_{12} policy Model II (ft^3)	b_{13} policy Model III (ft^3)	Absolute difference* (ft^3)	Percentage difference*
Confederation Park	-144.9	-196.6	51.7	26.3
Pacific Heights	-139.8	-137.8	2	1.5
Brevoort Park	-138.6	-146.4	7.8	5.3
Parkridge	-104.1	-124.9	20.8	16.7
Montgemry Place	-102.8	-182.5	79.7	43.7
Westview	-92.9	-34.5	58.4	169.3
Dundonald	-80.3	-191.5	111.2	58.1
Varsity View	-77.5	-35.9	41.6	115.9
Fairhaven	-77.1	-78.1	1	1.3
Meadowgreen	-73.8	-63.3	10.5	16.6
Haultain	-71	-49.9	21.1	42.3
Greystone Heights	-67.8	-80.4	12.6	15.7
Wildwood	-52.6	-92.1	39.5	42.9
Avalon	-50.9	-62.3	11.4	18.3
Nutana	-50.4	21.9	72.3	330.1
Buena Vista	-45.9	0	45.9	
Queen Elizabeth	-44.5	-36.8	7.7	20.9
Forest Grove	-6.5	-18.6	12.1	65.1
Arbor Creek	5.5	24.2	18.7	77.3
Erindale	20.1	-43.7	63.8	146.0
Eastview	41.1	37.3	3.8	10.2
Westmount	68.4	127.4	59	46.3
Average difference			**34.2**	**60.5**

* Absolute difference = $(b_{12}) - (b_{13})$

** percentage difference = $\{(b_{12}) - (b_{13})\} / (b_{13})$

APPENDIX F

City of Saskatoon Releases during June and July to reduce outdoor water consumption

Release No. 1

Title: City Asks Residents to Reduce Water Usage Immediately

For Immediate Release June 13, 2011

US11-263

Effective immediately, the City of Saskatoon is asking all residents to voluntarily postpone lawn and garden watering at homes and businesses until Friday, June 17. In addition, the City asks that citizens take any steps they can to reduce water use in the home, such as deferring use of clothes washers and reducing shower times.

The request for voluntary reduction in water consumption is a result of emergency repairs required on one of the clarifiers at the Water Treatment Plant. These repairs mean the Water Treatment Plant cannot produce as much drinking water as usual. Crews are already working to repair the clarifier and it is expected it will be operational within three or four days, barring unforeseen circumstances. These repairs do not effect Saskatoon's drinking water quality.

The voluntary water reduction request should allow the Water Treatment Plant to keep up with city-wide demand, and mandatory restrictions will not be necessary. The city's Parks Branch has been notified and it is shutting off all parks irrigation systems.

The City of Saskatoon will notify residents when the clarifier is repaired and full plant capacity resumes. The City thanks everyone for their cooperation.

Release No. 2

Title: City Reminds Residents to Reduce Water Usage Immediately

For Immediate Release: June 15, 2011

US11-269

The City of Saskatoon would like to thank residents for voluntarily reducing their water usage while the Water Treatment's largest clarifier undergoes emergency repairs. Unfortunately, daily water use in Saskatoon remains high, and more reductions in water use are necessary to ensure the Water Treatment Plant can continue to meet city-wide demand. Any steps residents can take to reduce water use, including postponing lawn and garden watering, deferring use of clothes washers and dishwashers, and reducing shower times, are needed.

Crews continue to make repairs, and it is expected that the Plant will be fully operational by end of day Friday, barring unforeseen circumstances. These repairs do not affect Saskatoon's drinking water quality.

The City has been shutting off park watering and is now requesting that residents not use spray parks during this restriction. Spray parks will remain functional during the restrictions but residents are asked to voluntarily stay away. Some watering may still take place in locations that use raw water direct from the river.

If water usage is not further reduced within the next 18 to 24 hours, further restrictions may be necessary.

The City of Saskatoon will notify residents when the clarifier is repaired and full plant capacity resumes. The City thanks everyone for their cooperation.

Release No. 3

Title: Mandatory Water Restriction in Effect Immediately

For Immediate Release: June 15, 2011

US11-272

The City of Saskatoon is putting mandatory water restrictions into effect immediately which means residents must reduce their water usage significantly. Although the equipment that failed on Monday is now repaired the filters at the plant became partially plugged as a result and staff are working around the clock to restore the plant to normal operating conditions. Unfortunately high sand loads from the river water are compounding the problems at the plant, resulting in reduced output.

Unfortunately, daily water usage in Saskatoon has remained high, and further reductions in water use are essential. Residents must not use water outside their homes including postponing lawn and garden watering. Domestic water use for cooking, cleaning, and other in-house activities is still appropriate but it would be beneficial if residents would defer washing clothes, refrain from using dishwashers, and reduce shower times.

Water quality is not affected.

The City has already stopped watering parks and in the process of turning off the spray park water supply. Some watering may still take place in locations that use raw water directly from the river.

The City will of Saskatoon will notify residents when the clarifier is repaired and full plant capacity resumes. At this time, we are expecting the plant to restore the normal operations by end-of-day Friday, barring unforeseen circumstances. The City thanks everyone for their cooperation.

Release No. 4

Title: Mandatory Outdoor Irrigation Water Restrictions Still in Effect

For Immediate Release: June 22, 2011

US11-295

The mandatory outdoor irrigation water restriction for Saskatoon and area continues, however, the request to limit the use of indoor water, outdoor spray parks, and the Kinsmen Play Village paddling pool has been lifted. The City greatly appreciates the efforts of citizens to reduce water use outside and inside the home. The outdoor irrigation restriction remains in place because full capacity is still not possible at the Water Treatment Plant. Saskatoon Fire & Protective Services staff can issue tickets, starting at $300, if non-compliance with the outdoor restriction is reported and proven.

Ongoing filtering problems, which is the main reason full capacity is not possible, is due to the high levels of sand being drawn into the plant from the fast-flowing river. It is unknown at this time when the outdoor irrigation restriction will be lifted.

Residents in nearby towns and cities who receive their water from SaskWater including Warman, Osler, Martensville, Aberdeen, Dalmeny, Allen, Hague, and Clavet, are also asked to restrict outdoor water use as reductions in these centres also make a difference in demand.

The City of Saskatoon will notify residents once full plant capacity resumes and the outdoor irrigation restrictions are lifted.

Release No. 5

Title: Efforts by Residents/Businesses to Restrict Water Use is Making a Huge Difference, but Mandatory Outdoor Water Restrictions Still in Effect

For Immediate Release: June 20, 2011

US11-286

The mandatory water restrictions for Saskatoon and area will remain in effect until end of day Wednesday, June 22. The City greatly appreciates the efforts of residents to reduce water use outside and inside the home over the last week as efforts have reduced demand by 32%. Residents can now resume normal indoor water use as Plant conditions have improved, but outdoor restrictions remain in place. Saskatoon Fire & Protective Services staff can issue tickets, starting at $300, if non-compliance with the outdoor restriction is reported and proven.

Measures to restore filter capacity at the Water Treatment Plant are improving daily, but the Plant is still not operating near full capacity. The problems with the filters is the result of high levels of sand being drawn into the Plant from the fast-flowing river, and lasting effects on the filter media due to clarifier mechanical and chemical problems.

Residents in nearby towns and cities who receive their water from SaskWater including Warman, Osler, Martensville, Aberdeen, Dalmeny, Allen, Hague, and Clavet, are also asked to restrict outdoor water use as reductions in these centres also make a difference in demand.

The City of Saskatoon will notify residents once full plant capacity resumes and the restrictions can be lifted.

Release No. 6

Title: Updated Declaration of Mandatory Outdoor Water Restrictions

For Immediate Release: June 24, 2011

US11-306

The mandatory outdoor irrigation water restriction is in place from 12:00 p.m. today, June 24 until 11:59 p.m. Friday, July 15, unless earlier discontinued or extended**.**

Watering of lawns is prohibited, except:

- Buildings with lawn turf placed within the previous 14 days, or lawns seeded within the last 30 days, may water such turf or seeded lawn each day before 6:00 a.m. or after 9:00 p.m.

Watering of gardens is prohibited, except:

- By use of a hand-held watering can or pail.

The washing of driveways and cars outdoors is also prohibited. Car wash businesses are not included in this restriction.

Dated: June 24, 2011

Brenda Wallace

Acting General Manager, Utility Services Department

The City greatly appreciates the efforts of citizens. The outdoor irrigation restriction remains in place because full capacity is still not possible at the Water Treatment Plant. Continuing filter problems, which greatly restrict daily production capacity, are due to the high levels of sand, clay and silt being drawn into the plant from the fast-flowing river. To give this number some context, the plant is currently seeing the equivalent of 10 dump trucks (100 cubic yards) of sand coming into the plant every three days.

Saskatoon Fire & Protective Services staff can issue tickets, starting at $300, if non-compliance with the outdoor restriction is reported and proven. Residents within Saskatoon can call 975-2828 to file a complaint about non-compliance during a water restriction.

Conservation efforts by citizens are also encouraged during this time of restriction and throughout the summer. Some general tips for your lawn and garden include:

- Use rain barrels on your property to catch and store rain water. Not only is this a great, fresh water source for watering your garden and pots, it's free!
- By keeping your grass longer, approximately 3 inches high, the soil will retain more moisture and less watering will be necessary.

Residents in nearby towns and cities who receive their water from SaskWater including Warman, Osler, Martensville, Aberdeen, Dalmeny, Allen, Hague, and Clavet, are also asked to restrict outdoor water use as reductions in these centres also make a difference in demand.

The City is examining the implementation of an outdoor watering schedule as a short-term solution while the restrictions are in place. More information on that schedule will be released next week. Until then, all outdoor water use is restricted barring the exceptions listed above.

Release No. 7

Title: Outdoor Odd/Even Address Irrigation Schedule Beginning This Evening, June 28, and the Updated Declaration of Mandatory Outdoor Water Restrictions

For Immediate Release: June 28, 2011

US11-314

The City greatly appreciates the efforts of citizens to reduce their water use. Reduced water use has been a critical factor in enabling the Water Treatment Plant to meet basic water needs of citizens, and has enabled staff to make adjustments at the Plant to better deal with the sand and silt loading caused by high-river levels. Plant capacity has been partially restored, and as such the City is able to take measured steps towards lifting the water use restrictions. Spray Parks will remain open, and paddling pools will be opened in phases later this week. The City will be carefully monitoring water consumption to ensure the Plant can continue to meet demand, and will adjust the restrictions if required. **Remember not to overwater.** Please see the official declaration for the irrigation schedule for citizens.

The outdoor irrigation restrictions remain in place because full capacity is not possible at the Water Treatment Plant. Continuing filter problems, which greatly restrict daily production capacity, are due to the high levels of sand, clay, and silt being drawn into the plant from the fast-flowing river. By restricting outdoor irrigation to the late evening and early morning, when indoor use and business use is low, the plant is expected to be able to handle the additional demand.

Conservation efforts by citizens are also encouraged during this time of restriction and throughout the summer. Lawns and gardens only need an inch of water every week, and it is better for the plant's root system to water deeply.

Some general tips for your lawn and garden include:

- Use rain barrels on your property to catch and store rain water. Not only is this a great, fresh water source for watering your garden and pots, it's free!

- By keeping your grass longer, approximately 3 inches high, the soil will retain more moisture, and less watering will be necessary.

- Water your lawn/garden only once a week, and skip a week after a good rain. Soil should be allowed to dry between watering to encourage root development.

- Water your lawn/garden deeply, approximately 1 inch, at each watering. One way to judge an inch of water is to place empty tuna cans or an upside down Frisbee on your lawn. When the container is full, you have watered one inch. The time to fill the container will vary depending on the type of sprinkler or irrigation method.

Saskatoon Fire & Protective Services staff have the ability to issue tickets, starting at $300, for non-compliance when the outdoor restriction is reported and proven. Residents within Saskatoon can call 975-2828 to file a complaint about non-compliance during a water restriction.

Residents in nearby towns and cities who receive their water from SaskWater including Warman, Osler, Martensville, Aberdeen, Dalmeny, Allen, Hague, and Clavet, are also asked to restrict outdoor water use as reductions in these centres also make a difference in demand.

Revised Official Declaration - The mandatory outdoor irrigation water restriction is in place from 4:00 p.m. on June 28 until 11:59 p.m. on Friday, July 15, unless earlier discontinued or extended.

Watering of lawns/gardens is prohibited, except:

- Commencing at 9:00 p.m. on Tuesday, June 28, lawns/gardens at buildings with street addresses ending in an odd number, or do not have a street address (like a community garden), may be watered on Tuesdays and Saturdays before 6:00 a.m. or after 9:00 p.m.

- Commencing at 12:00 a.m. on Wednesday, June 29, lawns/gardens at buildings with street addresses ending in an even number may be watered on Wednesdays and Sundays before 6:00 a.m. or after 9:00 p.m.

- Buildings with lawn turf placed within the previous 14 days, or lawns seeded within the last 30 days, may water such turf or seeded lawn each day before 6:00 a.m. or after 9:00 p.m.

Dated: June 28, 2011

Jeff Jorgenson

General Manager, Utility Services Department

Release No. 8

Title: Outdoor Odd/Even Address Irrigation Schedule Adjusted-Updated Declaration of Mandatory Outdoor Water Restrictions

For Immediate Release: July 7, 2011

US11-327

Effective immediately, the City is adjusting the outdoor watering times for citizens. Buildings with odd-numbered addresses will now be able to water their lawns and gardens at any time of the day on Tuesdays and/or Saturdays. Buildings with even-numbered addresses will now be able to water their lawns and gardens at any time of the day on Wednesdays and/or Sundays. Please see the official declaration for more details.

The time restriction on outdoor watering has been adjusted for two reasons. First, the Water Treatment Plant continues to improve capacity and is at approximately 80% of normal. Anticipated significant reductions in river flow and improved filter capacity have allowed this. Second, citizens are experiencing low water pressure during the allowable evening watering due to the extensive amount of irrigation that is occurring.

The City greatly appreciates the efforts of citizens to reduce their water use. Reduced water use has been a critical factor in enabling the Water Treatment Plant to slowly restore plant capacity. The outdoor irrigation restrictions will remain in place until Friday, July 15, or when full capacity at the plant is once again possible.

The City continues to encourage conservation efforts by citizens. Lawns and gardens only need 1 inch of water every week, and it is better for the plant's root system to water deeply. **Remember not to overwater and to use water wisely.**

Some general tips for your lawn and garden include:

- Use rain barrels on your property to catch and store rain water. Not only is this a great, fresh water source for watering your garden and pots, it's free!

- By keeping your grass longer, approximately 3 inches high, the soil will retain more moisture, and less watering will be necessary.

- Water your lawn/garden only once a week, and skip a week after a good rain. Soil should be allowed to dry between watering to encourage root development.

- Water your lawn/garden deeply, approximately 1 inch, at each watering. One way to judge an inch of water is to place empty tuna cans or an upside down Frisbee on your lawn. When the container is full, you have watered 1 inch. The time to fill the container will vary depending on the type of sprinkler or irrigation method.

Saskatoon Fire & Protective Services staff have the ability to issue tickets, starting at $300, for non-compliance when the outdoor restriction is reported and proven. Residents within Saskatoon can call 975-2828 to file a complaint about non-compliance during a water restriction.

Revised Official Declaration - The mandatory outdoor irrigation water restriction is in place from 4:00 p.m. on Thursday, July 7, until 11:59 p.m. on Friday, July 15, unless earlier discontinued or extended.

Watering of lawns/gardens is prohibited, except:

- Lawns/gardens at buildings with street addresses ending in an odd number, or do not have a street address (like a community garden), may be watered on Tuesdays and Saturdays at any time of the day.

- Lawns/gardens at buildings with street addresses ending in an even number may be watered on Wednesdays and Sundays at any time of the day.

- Buildings with lawn turf placed within the previous 14 days, or lawns seeded within the last 30 days, may water such turf or seeded lawn each day at any time of the day.

- Companies and citizens may water following lawn fertilization on the day of the application of the fertilizer at any time.

- City-maintained parks and sport fields may be watered on Mondays, Thursdays, and Fridays at any time of the day.

Dated: July 7, 2011
Jeff Jorgenson
General Manager, Utility Services Department

Release No. 9

Title: City Ends Mandatory Water Restriction Effective Today, Monday, July 11

For Immediate Release: July 11, 2011

US11-333

The City of Saskatoon has ended the mandatory water restriction order effective today, Monday, July 11, that was originally issued on June 15. Residents can now use water for all purposes.

The City thanks residents for their compliance with the restrictions. By conserving water over the past several weeks, residents significantly reduced demand on the Water Treatment Plant which was a significant factor in enabling staff to restore the Plant to full capacity.

"We sincerely thank everyone in Saskatoon for their compliance with the mandatory water restrictions," said Reid Corbett, Water & Wastewater Manager. "The efforts of residents made a huge difference on our water demands during this difficult time."

Being water wise is always a good idea. The City reminds residents that lawns and gardens only need 1 inch of water every week, and it is better for the plant's root system to water deeply. Some general tips for your lawn and garden include:

- Use rain barrels on your property to catch and store rain water. Not only is this a great, fresh water source for watering your garden and pots, it's free!
- By keeping your grass longer, approximately 3 inches high, the soil will retain more moisture, and less watering will be necessary.
- Water your lawn/garden only once a week, and skip a week after a good rain. Soil should be allowed to dry between watering to encourage root development.

- Water your lawn/garden deeply, approximately 1 inch, at each watering. One way to judge 1 inch of water is to place empty tuna cans or an upside down Frisbee on your lawn. When the container is full, you have watered one inch. The time to fill the container will vary depending on the type of sprinkler or irrigation method.

Release No. 10

Title: Official Declaration - The mandatory outdoor irrigation water restriction has ended effective immediately.

For Immediate Release: July 11, 2005

US05-202

Dated: July 11, 2011

Jeff Jorgenson

General Manager, Utility Services Department

The City of Saskatoon has now lifted the mandatory water rationing order that was issued on Saturday afternoon. Residents can now use water for all purposes.

The City thanks residents for their compliance with the order. By conserving water over the weekend, residents reduced demand on the Water Treatment Plant by 20%. That assistance, combined with the efforts of City crews to complete repairs to the equipment, helped lift the water restriction faster than expected.

Spray and paddling pools that were closed yesterday due to water rationing will be open later today. Some pools take longer than others to fill. Regular playground schedules will still be in effect. The City also turned off its automated sprinkler systems in parks across Saskatoon.

“We sincerely thank everyone in Saskatoon for being such great citizens. Their water conservation efforts made a huge difference in our water demands during this difficult time” said Mark Keller, Manager, Water and Wastewater Treatment Branch.

The high river flows over the past few weeks created a huge amount of sand that clogged the Water Treatment Plant’s equipment. Crews worked around the clock this past week to unclog the equipment. Water quality was not affected in anyway; just the ability to produce was reduced.